

DRAFT

Report of the  
**Surface Impoundments Study Subcommittee**

**December 7, 2001**

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**WASHINGTON D.C. 20460**

December 1, 2001

OFFICE OF  
THE ADMINISTRATOR  
EPA SCIENCE ADVISORY BOARD

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The SAB is not soliciting comments on the advice contained herein. However, comments on the issues listed below could be helpful.

1. Has the Committee adequately responded to the questions posed in the Charge?
2. Are any statements or responses made in the draft unclear?
3. Are there any technical errors?

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DATE

EPA-SAB-EEC-02-XYZ

**DRAFT**

Honorable Christine Todd Whitman  
Administrator  
U.S. Environmental Protection Agency  
1200 Pennsylvania Avenue, NW  
Washington, DC 20460

Re: Review of the Office of Solid Waste's Study, *Industrial Surface  
Impoundments in the United States*

Dear Governor Whitman:

1 The Surface Impoundments Study Subcommittee of the Science Advisory Board's  
2 Environmental Engineering Committee recently reviewed the Office of Solid Waste's study,  
3 *Industrial Surface Impoundments in the United States*. This study, prompted by the Land  
4 Disposal Program Flexibility Act and an Environmental Defense Fund consent decree,  
5 was conducted on impoundments used to manage industrial nonhazardous waste. EPA  
6 estimates that there are close to 20,000 such surface impoundments in use throughout the  
7 United States. Until this study, relatively little was known about these facilities with regard  
8 to their human-health and ecological risks and potential regulatory gaps.

9 The Office of Solid Waste invited the Science Advisory Board to review the study  
10 because EPA will use the study results to decide whether, and if so, how, to apply the land  
11 disposal restrictions or take other appropriate actions to address risks found.

12 Overall, the Subcommittee found that the study contains an extensive analysis rich  
13 with new, relevant and useful information. With the caveat that the study addresses human  
14 health risks for direct pathways at steady state, the Subcommittee believes the Office of  
15 Solid Waste's work is defensible. If resources were available, more work on indirect  
16 pathways, ecological risks, and transient events would enlarge the understanding of the  
17 risks posed by these facilities. Although the Subcommittee has provided  
18 recommendations for additional improvements, the Subcommittee found the work to be of  
19 good quality and, therefore, encourages the Office of Solid Waste to seek publication in  
20 peer-reviewed journals.

21 EPA has made excellent use of the data it collected, linking numerous factors to  
22 estimate both human health and ecological risks posed by surface impoundments.  
23 Although there is not yet enough data for detailed quantitative assessments of all relevant  
24 scenarios, other informative analyses are possible which can be helpful in managing the  
25 risks from surface impoundments. Further, these analyses have the advantage of less  
26 uncertainty than the quantitative risk assessments. Therefore, the Subcommittee suggests

1 that EPA expand its empirical analysis of data and develop conclusions on national risk  
2 profiles based mostly on the tier 2 analyses.

3 The Subcommittee was also very impressed by the staff who prepared for the  
4 review. In particular, the deep and extensive knowledge displayed by Barnes Johnson,  
5 Becky Cuthbertson and Jan Young were notable. In its efforts to provide a sound scientific  
6 basis for decision-making, the staff sought and utilized input from the SAB and other  
7 external peer reviewers in developing the study and made use of the Agency's Quality  
8 System in its execution. These measures, coupled with the hard work of the staff,  
9 contributed to the quality of the study and should provide a positive example to others  
10 undertaking similar work.

11 We look forward to your consideration of and response to the enclosed report.

12 Sincerely,

13 Dr. William Glaze, Chair  
14 EPA Science Advisory Board  
15

Dr. Domenico Grasso, Chair  
Environmental Engineering Committee  
EPA Science Advisory Board

16 Dr. Byung R. Kim, Chair  
17 Surface Impoundments Study Subcommittee  
18 EPA Science Advisory Board  
19  
20

## NOTICE

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## 1 EXECUTIVE SUMMARY

The Office of Solid Waste (OSW) requested that the Science Advisory Board (SAB) review its Industrial Surface Impoundments in the United States report, the appendices, and attachments to the appendices, along with other relevant materials. The SAB's Environmental Engineering Committee formed a Surface Impoundments Study Subcommittee to conduct this review. At a series of public conference call meetings and a face-to-face meeting October 24-26, 2001, the Subcommittee responded to the six major charge questions for the review, addressed research needs, and provided some remarks on the EPA's responsiveness to the previous SAB review and its use of other external peer review processes. The charge may be found in Chapter 2. The findings and recommendations are addressed at length in Chapter 3. A summary of the major findings and recommendations is provided here.

The Subcommittee endorses the multi-tiered risk characterization methodology adopted by EPA to meet the legal requirements specified under the statute and consent decree. The probabilistic sampling design supported the generation of defensible national human health risk estimates associated with the potential direct exposure from chemicals managed in surface impoundments. Although a national profile reflecting the probable human-health risks associated with direct chemical exposure was achievable through application of the risk characterization methodology, the incomplete characterization of site-specific uncertainty factors reduces EPA's ability to draw defensible risk assessment conclusions from any particular surface impoundment. The Subcommittee encourages EPA to consider addressing uncertainty by expanding its current use of risk indices in developing a risk characterization framework that is less dependent on a quantitative assessment of uncertainty.

The Subcommittee endorses the EPA's use of the risk screening methodology for identifying those surface impoundments that represent potentially significant indirect human-health and ecological risks. However, to ensure that future risk-management decisions are based on a complete and balanced characterization of potential risks, the Subcommittee recommends that EPA develop and implement a quantitative assessment of indirect human-health and ecological risks associated with surface impoundments.

The Subcommittee recognizes three types of abnormal operating conditions, namely, changes in wastewater characteristics, storm events that can result in catastrophic releases of pollutants from impoundments, and structural failures due to groundshaking in seismically active regions of the United States. Of these abnormal operating conditions, storms merit the most attention.

1 In the report developed by EPA, abnormal operating conditions have not been  
2 given adequate attention. In order to adequately evaluate the impacts of storm events on  
3 the operation of impoundments and resulting human-health and ecological risks in  
4 vulnerable areas of the United States, collection of additional data, and/or mining of  
5 collected information on the patterns of storm impact on impoundments are required. EPA  
6 could draw some conclusions from such data with regard to those abnormal operating  
7 scenarios that could impact the risks the most without waiting for the results of full-blown  
8 risk assessments.

9 If the information indicates that transient events have had or could have significant  
10 impacts on risk factors, then EPA should conduct more detailed analysis to integrate  
11 methodologies with defensible assumptions into its overall risk assessment framework.  
12 The methodologies that should be considered for the integration include the factor of safety  
13 approach, the zero containment assumption, and modeling of impoundment degradation  
14 and consequent contaminant release during the active operating life of the impoundment.  
15 In order to adequately accommodate the effects of transient events, some elements of the  
16 risk assessment framework may need to be probabilistic.

17 The screening-level ecological and indirect human-health risk analyses were  
18 performed using appropriate methodology, although the Subcommittee recommends that  
19 a more quantitative assessment of these risks be undertaken in the future. Most potentially  
20 significant pathways were included in these analyses, although a more comprehensive,  
21 indirect-pathway risk assessment would add effects of transient events and indoor routes  
22 of exposure such as volatile chemicals in home shower water. Additionally, the  
23 Subcommittee was not able to evaluate the error associated with the lack of toxicity data  
24 for some chemicals and therefore recommends that the conclusions of the screening-level  
25 risk assessments (i.e., percentage of facilities) be presented in two categories: facilities  
26 with "potential risk" and those with "risk below threshold of concern." If EPA desires to  
27 categorize further facilities presenting potential risk, the Subcommittee recommends that  
28 they do so in a literal manner (e.g., "potential risk from 2 or more pathways") rather than  
29 using subjective adverb descriptors. The conclusion that the vast majority of surface  
30 impoundments pose potential ecological risk should be stated more clearly in the  
31 executive summary, perhaps with caveats that a definitive, quantitative assessment has  
32 not been performed.

33 Survey data were often incomplete and for certain facilities concentration data gaps  
34 would have prevented risk assessment. To allow risk assessment to proceed, EPA  
35 developed surrogate protocols to address data gaps created by; missing sludge  
36 concentrations, non-detect data, and wastewater contaminants reported as present but  
37 with no concentration values. The Subcommittee found that these surrogate protocols were  
38 generally conservative from the perspective of protecting human health and the

1 environment and suitable for the purposes of this study. Due to the importance of  
2 concentration data, the Subcommittee recommends that the EPA explore the sensitivity of  
3 risk estimates to contaminant concentrations and to employ field-sampling data to  
4 groundtruth the surrogate protocols.

5 EPA collected field samples at twelve judgmentally selected facilities to evaluate  
6 the accuracy of survey data. The concentrations measured during field sampling were  
7 generally greater than the concentrations reported in the survey, which indicates that risk  
8 assessment using survey data is conservative. The field sampling also indicated that the  
9 survey data were incomplete with significantly more contaminants being detected in the  
10 field samples than in the survey data. The Subcommittee recommends that EPA; a)  
11 explore the reasons for the positive bias and non-detect contaminants in the survey data  
12 and b) employ the field data to groundtruth the surrogate data protocols. The  
13 Subcommittee also found and concurs with the EPA that a probabilistic selection of  
14 facilities and sampling locations within impoundments for the field sampling would have  
15 increased confidence in the representativeness of the samples and the ability to  
16 extrapolate to the larger national population of impoundments.

17 The Subcommittee supports the EPA approach of using impoundment wastewater  
18 composition to define the groundwater source term for steady-state impoundment  
19 operation, and does not recommend a bounding analysis using available sludge data. The  
20 available sludge data are inadequate in the scope of constituents and conditions  
21 represented, and calculating leachate concentrations from sludge concentrations would  
22 necessitate assumptions that would lead to substantial uncertainty in the estimates  
23 obtained. The use of impoundment wastewater composition to represent impoundment  
24 leachate composition for steady-state impoundment operation is a reasonable,  
25 conservative approach given the limited submittal of leachate data by survey respondents.  
26 The Subcommittee recommends, however, that EPA confirm the conservative nature of its  
27 approach to groundwater source concentration by comparing leachate concentration data  
28 with impoundment wastewater concentration data for those facilities that have reported  
29 both sets of data. In the event that leachate concentrations are found to be consistently  
30 greater than wastewater concentrations for some constituents, then EPA should consider  
31 the use of the average leachate/wastewater concentration ratio for these constituents as a  
32 scaling factor. It would also be useful to demonstrate systematically that the main  
33 conclusions from the groundwater pathway risk analysis would not be changed if source  
34 area constituent concentrations were higher, e.g., by an order of magnitude. A sensitivity  
35 analysis could be performed to examine the effects of increases in constituent source  
36 concentrations. It seems unlikely that differences in the source area concentrations in the  
37 range of an order of magnitude will change the main conclusions reached in the study.

1           Several areas of future research are recommended with regard to the estimation of  
2 human-health and ecological risks associated with surface impoundments. These areas  
3 deal with issues on performance of surface impoundments, human health, ecological risks  
4 (including bioaccumulation), fate and transport (through air, groundwater, soil, and sludge),  
5 fate and transport (through uptake and bioaccumulation), risk assessment methodologies  
6 (model development and validation), and risk mitigation measures. The areas should be  
7 prioritized based on their relative impact on the reduction of uncertainty for estimating the  
8 risks. Therefore, it would be helpful to conduct sensitivity analyses to identify sensitive  
9 parameters. For these parameters, a higher priority should be given to those that have not  
10 been considered in estimating the risks or do not have sufficient data.

11           The Subcommittee considered how well the EPA followed the advice given in its  
12 1998 report and found that the EPA implemented design followed to a great degree the  
13 SAB's advice, (e.g., phased approach based on conservative assumptions.). The 1998  
14 SAB report recommended that the EPA use a structured planning process to design the  
15 entire study. Although EPA used the structured planning for the field sampling only, their  
16 contemporaneous peer-review process, to a great degree, addressed this lacking.  
17 Indeed, the Subcommittee commends EPA on its use of peer review during the different  
18 phases of the study. The attention that OSW paid to this essential quality assurance  
19 mechanism should become an example for future studies.

## 2 INTRODUCTION

This chapter of the report provides the background, context, charge for the review and the procedural history. Specific responses to charge questions can be found in Chapter 3 while findings and recommendations on issues beyond the charge are presented in Chapter 4.

### 2.1 Background

#### 2.1.1 What are Surface Impoundments?

Essentially, surface impoundments are artificial ponds containing waste-water of one sort or another. In the United States there are thought to be 30,000 surface impoundments or more containing wastewater from agriculture, industry or mining or storm water. About 18,000 of these impoundments are industrial surface impoundments. OSW estimates that about two-thirds of these have high pH, low pH, or chemicals of concern.

Industrial impoundments vary greatly in size, from less than a quarter of a hectare (1/3 of an acre) to several hundred hectares. The larger impoundments provide the bulk of the total national industrial impoundment capacity.

In the United States, industrial surface impoundments are an important and widely used industrial materials management unit. Surface impoundments serve a variety of beneficial uses in a number of industrial processes. Industrial facilities that produce waste-waters often use surface impoundments to perform necessary wastewater treatment prior to discharge into surface waters. In other cases, industrial facilities may need to control wastewater flows and use surface impoundments for storing excess wastewater. In still other cases, industrial facilities may use surface impoundments to manage their excess waste-waters through evaporation or seepage into the ground.

Industrial impoundments frequently use management techniques that increase the potential for chemical releases and frequently are found in environmental settings that increase the potential for impacts to humans or ecosystems in the event of a chemical release. In this study, EPA found that most industrial impoundments are located only a few meters above groundwater and that, in most cases, shallow groundwater discharges to a nearby surface waterbody. More than half of the impoundments do not have liner systems to prevent the release of wastes to soil or groundwater. In addition, about 20 percent of impoundments are located within 150 meters of a fishable waterbody, so migration through the subsurface to the nearby surface water is possible. Finally, while aeration can have certain benefits, it also increases volatilization and the potential for airborne

contaminant migration. EPA found that about 45 percent of the total wastewater quantity managed in impoundments is aerated.

### **2.1.2 What Kinds of Wastes are Stored in Industrial Surface Impoundments?**

Waste-waters that are neither “characteristic” or “listed” hazardous wastes under RCRA may be found in industrial surface impoundments.<sup>1</sup> In developing the Industrial Surface Impoundments in the United States, EPA requested information on the presence and quantities of 256 chemical constituents of concern in the impoundments. More than half of the impoundments with chemical constituents or pH of concern are in the chemical, concrete, paper, and petroleum industries. The paper and allied products sector is of special interest because two thirds of the wastewater managed in surface impoundments comes from that industrial category.

### **2.1.3 What did Legislation and the Consent Decree Require?**

The Resource Conservation and Recovery Act, or RCRA, provides a “cradle to grave” regulatory scheme for hazardous wastes. 1984 amendments to RCRA required that EPA restrict the practice of placing hazardous wastes in land-based waste management units. A June 1, 1990 regulation implemented this restriction for “characteristic” hazardous wastes that are managed in wastewater systems. In that regulation, EPA interpreted the 1984 amendments to allow land placement of wastes that were formerly characteristic hazardous wastes, and were managed in wastewater systems, but that had been treated or diluted so that the characteristic hazard was removed. For simplicity, EPA refers to these wastes as “decharacterized” wastes, meaning the characteristic hazard has been removed, and they are no longer characteristic hazardous wastes. EPA was sued by Chemical Waste Management, Inc. over this interpretation. The court’s opinion was that RCRA required EPA to set treatment standards that minimize threats to human health and the environment.<sup>2</sup>

To comply with the court’s opinion, EPA promulgated a 1996 final regulation that in certain cases imposed treatment requirements before, during or after their placement in

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<sup>1</sup>The RCRA regulatory scheme delineates “characteristic” hazardous wastes as one type of hazardous waste; the other type is known as “listed” hazardous wastes. Characteristic hazardous wastes exhibit one or more of four separate hazardous properties: corrosivity, ignitability, reactivity, or toxicity.

<sup>2</sup>The specific issue in the case was the continued presence of ‘underlying hazardous constituents’ in the waste, even after the characteristic hazard was removed.

1 surface impoundments. Soon after the regulation was signed, Congress enacted the Land  
2 Disposal Program Flexibility Act of 1996, or LDPFA, which effectively rescinded the 1996  
3 regulations (but kept the treatment requirements in effect in limited circumstances).

4 In addition to these developments, in 1989, the Environmental Defense Fund  
5 (EDF) sued the U.S. Environmental Protection Agency (EPA), in part, for failing to meet  
6 the statutory deadlines of Section 3001(e)(2) of the Resource Conservation and Recovery  
7 Act (RCRA; *EDF vs. Whitman*; Civ.No. 89-0598 D.D.C.). To resolve most of the issues in  
8 the case, EDF and EPA entered into a consent decree that sets out an extensive series of  
9 deadlines for promulgating RCRA rules and for completing certain studies and reports. A  
10 1997 amendment to the consent decree required EPA to study human health risks from air  
11 inhalation of 105 chemical constituents present in surface impoundments. In the consent  
12 decree requirement, the waste in the impoundment is classified as nonhazardous under  
13 the federal RCRA regulations, but is also not the decharacterized waste at issue in the  
14 preceding two paragraphs. Together, the two provisions - the legislation and the consent  
15 decree - called on EPA to conduct a study of the risks associated with all nonhazardous  
16 waste surface impoundments.

17 Currently any ultimate discharge from industrial surface impoundments is subject to  
18 regulation under the Clean Water Act (CWA)

#### 19 **2.1.4 What was the Scope of the OSW's Surface Impoundments Study?**

20 EPA estimates that, in the 1990s, there were approximately 18,000 industrial  
21 surface impoundments in use throughout the United States. These surface impoundments  
22 were present at about 7,500 facilities located primarily east of the Mississippi River and in  
23 Pacific Coast states. Because of the scope of the universe, EPA conducted the study  
24 focusing on a sample of U.S. facilities that use impoundments to manage industrial  
25 nonhazardous waste.

26 Most of the facilities selected for the study were chosen randomly to ensure that the  
27 sample facilities would be representative of the facilities in the study population. EPA sent  
28 surveys to 221 facilities to collect information on their impoundments and the wastes  
29 managed in them. EPA requested information on the presence and quantities of  
30 256 chemical constituents of concern in the impoundments, as well as on the  
31 impoundments' design and operation. EPA used these data to characterize the potential  
32 risks that may be posed by managing the wastes in impoundments. The survey responses  
33 on the presence and concentrations of specific chemical constituents were particularly  
34 central to EPA's analysis. EPA also collected and analyzed wastewater and sludge from  
35 impoundments at 12 facilities in the study and used that information to illuminate the

completeness and accuracy of the survey data. EPA also used data from a variety of other sources such as facility permit files, U.S. Census data, and technical references.

OSW's report, Industrial Surface Impoundments in the United States, discusses risks to human health and the environment that may be posed by managing industrial nonhazardous wastes in surface impoundments. It provides 1) estimates of cancer and non-cancer human health risks for individuals, or "receptors," who may be exposed to releases from surface impoundments used to manage wastewaters and wastewater treatment sludges, 2) a screening analysis of other indirect pathway human health risks, and 3) a screening analysis of the potential risks to ecological receptors.

## **2.2 Context**

EPA will use the risk results, along with the analysis of existing regulatory and nonregulatory programs designed to address the risks (described in Chapter 4 of the report) to decide whether, and if so, how, to apply the land disposal restrictions or take other appropriate actions to address risks found.

## **2.3 Charge**

The Environmental Engineering Committee (EEC) of the Science Advisory Board (SAB) is requested to review the Industrial Surface Impoundments in the United States report, its appendices, and attachments to the appendices, dated March 2001, along with other relevant materials. Although any comments on the report are appreciated, EPA developed the following general and specific questions for the SAB:

### **1. Overall**

This study was a classic risk assessment for use in reviewing waste management practices at nonhazardous waste surface impoundments. It relied on primary data collected for the specific purpose of answering the study questions. The study's technical objective was to assess risks posed by the waste management practices described in the statute and consent decree. The study population consisted of facilities with three different types of Clean Water Act regulatory status: direct, zero, and indirect dischargers.<sup>3</sup> For direct and zero dischargers, the study design was a randomized two-phase sample of facilities, with all eligible impoundments selected at the second-phase sample facilities. We used a questionnaire to collect basic information regarding each facility and surface impoundment in the second-phase sample. We also collected publicly available data and

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<sup>3</sup>The legislation specified these three Clean Water Act categories, and thus defined the study population.

1 conducted a limited field sampling effort at some facilities. These data were used to  
2 develop a risk analysis to evaluate the nature and extent of human health and ecological  
3 impacts posed by these surface impoundments.<sup>4</sup>

4 The policy questions posed in the legislation and the consent decree were:  
5 “to characterize the risks to human health or the environment associated with [managing  
6 decharacterized wastes in Clean Water Act treatment systems]” and to “evaluate the extent  
7 to which risks are adequately addressed under existing State or Federal programs and  
8 whether unaddressed risks could be better addressed under such laws or programs.”  
9 (RCRA section 3004(g)(10))

10 and

11 The Administrator shall...perform [a] stud[y] on gaps in the hazardous waste  
12 characteristics and relevant Clean Air Act ("CAA") controls, and the resulting potential  
13 risks to human health, posed by the inhalation of gaseous and non-gaseous air emissions  
14 from wastes managed in...surface impoundments (excluding those impoundments  
15 receiving decharacterized wastewaters that the EPA is obliged to study pursuant to  
16 section 3004(g)(10) of RCRA, 42 U.S.C. S 6924(g)(10))....<sup>5</sup>

17 In offering an overall review of the study EPA asks the reviewers to keep these  
18 general questions in mind:

- 19 a) Does the Science Advisory Board believe that the general methodology we  
20 chose for developing our risk analysis was appropriate for the policy  
21 questions posed in the statute and consent decree?
- 22 b) Regarding the overall study implementation, from design through sample  
23 selection, data collection and analysis, what areas of strength do you see in  
24 the overall methodology, and what areas of potential improvement or  
25 additional analysis do you recommend?
- 26 c) Did EPA adequately characterize the risks? Are the risk analysis and  
27 findings transparent? That is, are they explicit in:

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<sup>4</sup>For indirect dischargers, the design was a purposive sample, with all eligible impoundments selected at the sampled facilities, collection of primary survey data, analysis of those survey data, and comparison with direct and zero discharger results.

<sup>5</sup>Civ. No. 89-0958, *Environmental Defense Fund, Inc. vs. Whitman et al.* June 12, 1997.

describing the assessment approach, assumptions, extrapolations  
and use of models

describing plausible alternative assumptions

identifying data gaps

distinguishing science from policy

describing uncertainty, and

describing the relative strength of the assessment?

- d) Please provide your assessment of the accuracy of EPA's overall study conclusions regarding risks to human health and the environment. Were the conclusions either false positive or false negative conclusions (finding risks of greater or lesser magnitude than the risks that likely exist)?

## **2. Abnormal Operating Conditions**

Regarding the releases that result from abnormal operating conditions, such as overtopping, or dike/berm failures, we asked survey respondents about the frequency, duration and magnitude of these kinds of events.<sup>6</sup> We presented the findings in Chapter 2, page 2-26, but did not attempt to incorporate this information into the risk assessment or otherwise perform failure modeling, due to concerns about the high non-response rate on this particular survey question, as well as possible memory effects (recall and reporting of more recent events).

- a) In light of the findings of the report, should EPA perform a more detailed evaluation of abnormal operating events, would the data collected point to additional studies or research to provide more detail about this issue? If so, what methods or approaches would the SAB recommend regarding collecting more reliable data, and modeling the probability and impacts of such events?

## **3. Screening-level risk characterizations**

For most pathways of potential concern, EPA conducted conventional risk assessments using well-developed and peer reviewed modeling tools. These analyses

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<sup>6</sup>See Attachment A-1, Survey of Surface Impoundments question C25.

1 resulted in formal estimates of risks or exceedances of health thresholds and were  
2 conducted for the direct ingestion of groundwater, direct inhalation and the examination of  
3 groundwater to surface water impacts on human health ambient water criteria.

4 For a variety of potential indirect exposures to human receptors, EPA conducted a  
5 screening level risk characterization. These included potential exposures through indirect  
6 pathways such as ingestion of crops, dairy products and fish that might be contaminated  
7 through a variety of transport mechanisms such as runoff from closed impoundments, or air  
8 dispersion onto nearby farmlands. This analysis consisted of a categorizing and ranking  
9 of exposure factors of potential concern for each facility in order to identify facilities where  
10 indirect pathways may be of potential concern, rather than a formal risk assessment.<sup>7</sup>

11 Similarly, EPA conducted a screening level risk characterization of potential  
12 ecological concerns. This assessment identified facilities where there could be ecological  
13 concerns provided there were direct contact and ingestion of surface impoundment  
14 contents by various ecological receptors, using conservative screening assumptions.<sup>8</sup>

15 The reasons we conducted screening level risk characterizations for indirect  
16 pathways and for potential ecological risks were that the available data and available  
17 modeling tools were less complete and less certain, and we wanted to present results in a  
18 manner commensurate with the level of certainty in the available data.

- 19 a) For the indirect human health and ecological screening-level analyses, in the  
20 SAB's view, do the results point to areas of potential future research? If so,  
21 do you have recommendations on prioritizing future studies in these areas?
- 22 b) Based on the screening-level estimates we developed for other indirect and  
23 ecological risks, did it appear that we overlooked potential problem areas?
- 24 c) Did we clearly describe and properly characterize the other indirect human  
25 health and ecological risk analyses?

#### 26 **4. Survey Data on Chemical Constituent Presence/Quantity**

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<sup>7</sup>EPA's methodology and results for describing the human health risks potentially posed by indirect pathways, other than the groundwater to surface water pathway, is described in the report in section 3.4 and Appendix C, beginning on page C-135.

<sup>8</sup>The methodology and results for describing the potential ecological risks is described in the report in section 3.5 and Appendix C, beginning on page C-159.

1 EPA used various data processing and analysis protocols to ensure consistency in  
2 interpreting survey data on a specific constituent's presence in an impoundment, or that  
3 constituent's quantity. EPA used analysis methods and presentation techniques to help  
4 distinguish and explain the various degrees of certainty in the findings. Please comment  
5 on the appropriateness of the application of these data processing and analysis protocols,  
6 and on the degree of clarity of the risk results presentation, in the situations described  
7 below.

8 Surrogate data.<sup>9</sup> In this situation, the survey respondent clearly indicated the  
9 presence of a particular chemical constituent in an impoundment, but did not indicate a  
10 corresponding quantity. EPA used the surrogate data protocol described in Appendix A to  
11 impute a value according to a specific hierarchy of assumptions. In the risk results, EPA  
12 presented findings of risks that were computed based on these surrogate values  
13 separately from findings of risks above the relevant threshold level that were computed  
14 based on reported survey values for chemical constituent quantities.

15 a) Is it likely that EPA's data imputation protocol, or "surrogate data protocol"  
16 for imputing waste composition data markedly affected the ultimate  
17 conclusions regarding potential risks? If so, in what direction did the  
18 protocol probably bias the conclusions?

19 b) Should EPA have used any other approaches for qualifying or presenting the  
20 data?

21 Detection limits.<sup>10</sup> There were various situations in which the specific chemical  
22 constituents were clearly indicated, but the quantities were unknown because the only  
23 information reported was that the chemical was not detected in a laboratory analysis. In  
24 the first such situation, the survey respondents provided the pertinent detection limits, and  
25 EPA's data processing and analysis protocols called for using the reported detection limit  
26 as the actual quantity present in the impoundment, for the purpose of performing the  
27 screening or risk assessment. In the second situation, the survey respondents provided  
28 the chemical's identity and some kind of indication that the chemical was present below  
29 some sort of detection limit, but the exact detection limit was not stated. Typically, the  
30 survey response included "ND" or "BDL"; EPA interpreted these responses as "nondetect"  
31 or "below detection limit." In this second situation, the data processing and analysis

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<sup>9</sup>See pages A-36 to A-38 of Appendix A, Study Design and Survey Data Collection and Processing.

<sup>10</sup>See pages A-35 and A-36 of Appendix A, Study Design and Survey Data Collection and Processing.

1 protocols called for using an EPA-generated default detection limit for the chemical  
2 constituent in question, and assuming that the constituent was present at that detection  
3 limit. In either of these situations, EPA kept findings of risks above the relevant threshold  
4 level that were computed based on these detection limit values separate from findings of  
5 risks above the relevant threshold level that were computed based on reported survey  
6 values for chemical constituent quantities.

7 c) Was using the assumption that a chemical could be present up to the  
8 detection limit, when it was reported as being present below a detection  
9 limit, a reasonable concentration to choose for risk screening purposes?  
10 Was this assumption reasonable in cases where the constituent was not  
11 expected to be present at the facility?

12 d) Did the EPA-generated default detection limit protocol provide reasonable  
13 approximations of likely detection limits encountered in the field by the  
14 facilities, when the detection limits were not reported in the laboratory  
15 analysis?

16 e) Do the results that are based on imputed/detection limit data suggest that  
17 further analysis is needed?

## 18 **5. Analysis and implications of field sampling data.**

19 Based on a comparison of the EPA field sampling results with the corresponding  
20 reported survey values for chemical concentrations/quantities, EPA concluded that the  
21 survey respondents generally did not systematically under report the quantities of chemical  
22 constituents present in the impoundments.<sup>11</sup>

23 a) Although there are limitations of performing the comparison of survey and  
24 field sampling waste composition data, what is the SAB's view on EPA's  
25 conclusions about the accuracy of the reported survey data on chemical  
26 constituent concentrations/quantities?

27 Based on a comparison of the EPA field sampling results with the corresponding  
28 reported survey information on chemical constituents present in the impoundments, EPA

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<sup>11</sup>See Attachment E-1 for a table showing the reported survey values and corresponding field sampling measurement results.

concluded that there may have been incomplete reporting of the entire suite of chemical constituents present in the impoundments.<sup>12</sup>

- b) What is the SAB's view on EPA's conclusion on the potential incomplete reporting of chemical constituents present?
- c) Would the SAB recommend alternate approaches, in order to obtain the best possible information regarding the exact chemical constituents present, given the same budget and time constraints?

## **6. Groundwater source term.**

In order to estimate potential risks posed by the groundwater and the groundwater to surface water pathways, EPA needed to represent the impoundment and its contents in a modeled system, in which the contaminants that enter the groundwater transport pathway are represented as a mass flux of contaminants from the impoundment into the groundwater system. This mass flux is the groundwater source term, and EPA needed data on the identity and quantity of chemical constituents entering the groundwater system in order to model it properly.

The survey requested data on chemical constituents and their quantities in leachate from the impoundments. Leachate is the portion of the waste that is managed in a waste management unit, but leaks ("leaches") out of the bottom or sides of a land-based waste management unit. Facilities that collect leachate from their impoundments were able to report on chemical constituent presence/quantities in leachate, but relatively few facilities in the study sample appear to collect their impoundments' leachate. Thus, relatively few facilities answered the questions on leachate composition. However, virtually all the facilities that supplied waste composition data at all supplied it for wastewater composition.

To perform the data analysis, EPA needed to take a step-wise, efficient approach, beginning with screening thousands of impoundment/chemical combinations and ultimately modeling some. For these purposes EPA used the wastewater concentration. In impoundments containing little or no sludge, using wastewater composition data would be a reasonable approximation for the mass flux into groundwater. However, in impoundments containing some sludge, it is reasonable to expect that the concentrations of some constituents present in the pore water of the sludge could be considerably different than the concentrations present in the impoundment wastewater. These

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<sup>12</sup>See Attachment E-2 for a table listing the facilities, impoundments and chemical constituents found in the field sampling but not reported on the survey.

1 concentrations would resemble the leachate composition more than the wastewater. A  
2 comparison of some of the field sampling data on sludges with the corresponding  
3 wastewater composition, indicates that, for certain chemical constituents, the decision to  
4 use wastewater concentration may have underestimated the contaminant mass by more  
5 than an order of magnitude.

- 6 a) Would the SAB recommend another approach for representing the  
7 groundwater source term, for example, performing a bounding analysis,  
8 using the sludge data, where available, to represent an upper bound of the  
9 groundwater source term, and using wastewater data as the lower bound, for  
10 those chemical constituents for which this situation may be an issue?
- 11 b) Compared to other sources of uncertainty in the groundwater and  
12 groundwater to surface water pathway analyses, how large a source of  
13 uncertainty does the decision to use wastewater composition data appear to  
14 introduce into the overall study conclusions?

## 15 **2.4 Procedural History of the Review**

16 Barnes Johnson, Director, Economics, Methods, and Risk Analysis Division of the  
17 Office of Solid Waste requested the review during the SAB's Call for FY2001(Check FY).  
18 The Environmental Engineering Committee considered this request at December 5-7,  
19 2001 meeting. The Committee appointed Dr. Kim as chair of a Surface Impoundments  
20 Study Subcommittee originally to include Drs. Dellinger, Kavanaugh, Maney, McFarland,  
21 and Theis of the EEC. The EEC had done a consultation on the plans for the surface  
22 impoundment study for OSW in September 1996 and reviewed a plans for the study in  
23 1997. The OSW also briefed the Committee about its study and noted that it had arranged  
24 for an external peer-review of certain elements of the study.

25 The EEC discussed the Surface Impoundments Study at two subsequent  
26 conference calls -- March 7 and May 2, 2001. During this period the review documents  
27 became available and a preliminary charge was drafted. Also, the SAB began to move  
28 towards a different approach towards Subcommittee formation known as "wide  
29 cast/narrow cast". Because the EEC had named Subcommittee members in December,  
30 a modified version of this new process was used to complete Subcommittee formation.  
31 Also, as the charge became clearer and other demands were made on the members of  
32 the EEC, Drs. Dellinger and Theis were reassigned from the this Subcommittee to other  
33 activities.

### 3 RESPONSE TO THE CHARGE

#### 3.1 Charge #1: An overall review of the study

This section addresses the three questions raised by OSW in their overall charge and, where relevant, provides separate discussions for human health effects and ecological risks.

##### **3.1.1 Does the SAB believe that the general methodology we chose for developing our risk analysis was appropriate for the policy questions posed in the statute and consent decree?**

By characterizing the human health and ecological risks associated with never characteristic and decharacterized wastes managed in surface impoundments, EPA addressed the relevant policy questions posed in the Land Disposal Program Flexibility Act (LDPFA) statute and consent decree. Although neither the regulatory statute nor the consent decree explicitly mandates a quantitative assessment of human health and ecological risks associated with management of wastes in surface impoundments, the EPA chose to conduct a multimedia risk assessment to characterize potential risk.

The Subcommittee supports the EPA's decision to adopt this approach to risk characterization because a quantitative risk assessment provides EPA decision-makers with an effective means both to quantify potential risks and establish a framework for defensible risk management decisions.

Although the Subcommittee endorses the general risk analysis methodology adopted by the EPA to address the specific policy questions, the specific steps that characterize the risk assessment methodology (including the number and types of assumptions) vary significantly depending on the particular contaminant exposure pathway under consideration. The level of structural disparity associated with the various risk assessment methods suggests that the type and/or magnitude of uncertainty that characterize the final risk results may not be comparable across exposure pathways. To provide greater transparency, the Subcommittee suggests that the EPA develop an influence diagram that clearly defines the structure of each exposure pathway risk assessment methodology, including the identification of key data inputs and type (*i.e.*, deterministic or probabilistic), intermediate variables, submodels used and the relationships that exist between the various components in the methodology.

The Subcommittee supports the EPA's decision to explicitly identify and characterize the major sources of uncertainty associated with each risk assessment methodology. Although a qualitative assessment of uncertainty is important to EPA

1 decision-makers, quantifying the impact of uncertainty (and variability) on the final risk  
2 results provides the EPA with an invaluable tool for defensible risk management decision-  
3 making. Maney asks, "Is the entire Subcommittee using the same definitions when the  
4 terms variability and uncertainty are used?" The Subcommittee recommends that the EPA  
5 establish a formalized and transparent process to disaggregate and quantify the influence  
6 of uncertainty and variability on all risk modeling estimates.

7 The Subcommittee supports the EPA's decision to employ the results from the  
8 Land Disposal Restriction (LDR) program and the consent decree to identify the 256  
9 chemicals or groups of chemicals that were evaluated in the current surface impoundment  
10 study. However, human health risks were fully evaluated only for those chemicals for which  
11 cancer potency values and non-cancer reference doses or concentrations were readily  
12 available. Chemicals or exposure routes without such health risk indices were excluded  
13 from the risk analyses. Similarly, the EPA neglected to account for the effects of  
14 biophysical and photoconversion of chemicals (e.g., mercury to methylmercury) on the final  
15 risk results.

16 To fully describe the potential risks associated with wastes managed in surface  
17 impoundments, the Subcommittee encourages EPA to evaluate and document the impact  
18 of excluding these chemicals on the final cancer and noncancer risk results. Furthermore,  
19 the Subcommittee recommends that the EPA develop, where possible, defensible  
20 approaches to generate surrogate health indices that could be used to estimate the cancer  
21 and noncancer risk for all chemicals identified in the study as posing a potential risk when  
22 managed in surface impoundments. In the absence of evaluating the risks associated  
23 with all identified chemicals and their potential transformation products, there is limited  
24 assurance that the chemicals posing the greatest hazards were actually captured by the  
25 risk assessment. Finally, because of the variability associated with human health  
26 response to chemical exposure, the Subcommittee recommends that the EPA consider  
27 characterizing the distribution of risk associated with surface impoundments to determine  
28 if these facilities represent a disproportional health concern for children and other high-risk  
29 groups.

30 **3.1.2 Regarding the overall study implementation, from design through**  
31 **sample selection, data collection and analysis, what areas of strength**  
32 **do you see in the overall methodology, and what areas of potential**  
33 **improvement or additional analysis do you recommend?**

34 **3.1.2.1 Human Health Risks**

35 The Subcommittee endorses the EPA's decision to employ a tiered approach for  
36 characterizing human health and ecological risks. The use of preliminary risk screening to

1 eliminate constituents and/or constituent-impoundment combinations that are associated  
2 with negligible risk from further quantitative analysis is a technically defensible approach  
3 for optimizing the use of limited resources. The Subcommittee commends the EPA for  
4 developing and implementing conservative assumptions within the risk screening  
5 procedure that minimize the elimination of constituents that could potentially represent  
6 significant risks to public health and the environment. Moreover, the Subcommittee  
7 supports the EPA's use of a probabilistic approach for quantifying human health risks  
8 associated with the groundwater exposure pathway. Employment of a probabilistic risk  
9 assessment approach provides the EPA decision-makers with a means of visualizing both  
10 the range of potential human health risk and the probability (or confidence) that the risk will  
11 be observed.

12 Although the overall framework for the risk characterization was technically sound,  
13 there were several procedural deficiencies that limit the use of the risk assessment results  
14 in making defensible risk management decisions. A critical omission in conducting the  
15 risk characterization studies was the failure of the EPA to explicitly establish an acceptable  
16 level of quality for data used in both the risk screening as well as in the risk modeling  
17 phases. EPA used various sources of data (including survey data, sampling data,  
18 literature values, modeling results, professional judgment *etc.*) to quantify the potential risks  
19 associated with wastes managed in surface impoundments and to compare these results  
20 with defined cancer, noncancer and ecological benchmarks. While the EPA is  
21 commended for documenting the sources of these data, the risk assessment methodology  
22 does not clearly describe whether the quality of the various data elements is of an  
23 acceptable level to support EPA decisions. Moreover, the risk characterization  
24 methodology neglects to describe how the uncertainty associated with data quality is  
25 propagated through the risk assessment process and is captured in the final risk modeling  
26 results.

27 The Subcommittee recommends that the EPA explicitly establish the appropriate  
28 level of quality for all data used in developing quantitative risk characterization results.  
29 This recommendation is consistent with EPA Order 5360.1, which requires that all EPA  
30 organizations follow a systematic planning process to develop acceptance criteria for the  
31 collection, evaluation and use of environmental data. Acceptance criteria are based on  
32 the ultimate use of the data and the required quality assurance (QA) and quality control  
33 (QC) practices required to support a decision. The application of the EPA's data quality  
34 objectives (DQO) process (EPA QA/G-4 – EPA/600/R-96/055) is an effective way to  
35 establish the minimum level of acceptable data quality. The DQO process is a  
36 scientifically based methodology used for defining the data quality requirements that are  
37 appropriate for the intended use of the data. The output of the DQO process is a data  
38 collection design that clearly defines the type, amount, and quality of data required to  
39 support a decision.

1       The Subcommittee supports the EPA's use of a probabilistic risk characterization  
2 approach for quantifying the human health risks associated with the consumption of  
3 contaminated groundwater. The probabilistic approach allows EPA decision-makers to  
4 evaluate the full range of potential human health risk as well as their probability of  
5 occurrence. In addition to establishing both the range and probability of certain risk,  
6 probabilistic analysis can be used to identify the key sources of variability and uncertainty  
7 in model inputs. When both the uncertainty and variability associated with input parameter  
8 values are significant, the output of a contaminant exposure model represents a hybrid  
9 distribution that contains some combination of true variability and uncertainty reflecting a  
10 lack of knowledge. Therefore, a quantitative evaluation of uncertainty (and, in some cases,  
11 variability) is critical for the proper interpretation of risk results as well as for the purposes  
12 of targeting further data collection and/or research. Because of its importance in  
13 interpreting risk results, the Subcommittee recommends that the EPA develop and  
14 implement a process to quantitatively evaluate the impact of uncertainty.

15       Finally, in evaluating the groundwater to surface water contaminant exposure  
16 pathways, infiltration rates were developed by employing the Hydrologic Evaluation of  
17 Landfill Performance (HELP) model, which used regionalized climatic and generalized  
18 soils data rather than site-specific information. Although the EPA states that the HELP  
19 model accounts for uncertainty in infiltration rates using a probabilistic simulation, the  
20 HELP model described in *Hydrologic Evaluation of Landfill Performance (HELP)*  
21 (EPA/600/R-94/168b) is not probabilistic but, rather a two-dimensional deterministic  
22 model used to perform water balances. The Subcommittee encourages the EPA to  
23 provide additional documentation describing the version of the HELP model used in the  
24 risk characterization methodology.

### 25           **3.1.2.2       Ecological Risks**

26       The screening-level ecological risk assessment does not fully characterize risks to  
27 the environment. The description of the ecological risk assessment is unclear about the  
28 credibility of ecological risks associated with surface impoundments. EPA should be  
29 more specific about why only the screening-level risk analysis was performed; Sect. 3.5  
30 does not state a justification. For example, the EPA could identify the areas of exposure  
31 and effects estimation that are unknown because of a lack of data. However, the  
32 Subcommittee encourages the EPA to provide a more accurate and complete  
33 characterization of exposure; for example by using transport equations from the human  
34 health risk assessment, and thus get closer to answering the question posed in the  
35 LDPFA.

36       The Subcommittee recommends that a more refined or definitive assessment be  
37 conducted (*i.e.*, a Phase II assessment similar to that proposed in the *Technical Plan* –

EPA 2000 previously reviewed by the SAB). The EPA states that a facility with impoundments that exceed the ecological risk criterion for one or more chemicals are carried forward for further analysis (p. C-159). Similarly, the EPA states that surface impoundments hazard quotients of one or greater may be assigned for further evaluation, depending on the results of the human health screening. The nature of the further analysis is not described, nor its scientific or policy connection with the human health screening. The Subcommittee recommends the following areas of potential improvement and/or additional analysis to support ecological risk assessment:

- a) The use of transport or multimedia models to improve exposure predictions
- b) The use of realistic home ranges for terrestrial vertebrates (the impoundment would represent a portion of the diet for most potential receptors)
- c) The use of realistic bioaccumulation models or factors for wildlife foods in sludge/soil matrices
- d) The improvement of the scientific basis for the decision to use a higher threshold HQ (e.g., 10 rather than 1) for potential risk of SI contamination to the plant community (p. C-178, are plants unique in their adaptation ability? (Are sludge/soils expected to support any vegetation cover?))
- e) The use of realistic assumptions about piscivore diets (what fraction of these surface impoundments really have a fish community dwelling in them that would support a population of piscivores?)
- f) The possible use of more recent extrapolation models for vertebrate toxicity
- g) A more detailed explanation (preferably, with references) of why the air pathway is not a credible pathway for exposure to ecological receptors (e.g., the direct uptake of semivolatile chemicals such as PCBs, PAHs, and elemental Hg by plant leaves may be more important than the uptake through the roots, even if the only source is from soil)

### **3.1.3 Did EPA adequately characterize the risks? Are the risk analysis and findings transparent? That is, are they explicit in:**

**Describing the assessment approach, assumptions, extrapolations and use of models**

**Describing plausible alternative assumptions**

**Identifying data gaps**

**Distinguishing science from policy**

**Describing uncertainty**

**Describing the relative strength of the assessment**

MANEY asks, "Have all of the above 7 questions been answered for human health and Ecology?"

**3.1.3.1 Human Health Risks**

In general, the tiered approach adopted by the EPA for characterizing human health and ecological risks associated with wastes managed in surface impoundments was appropriate and technically defensible. However, its implementation was inadequate to fully characterize risks and, therefore, the estimated risks associated with the various exposure pathways may have some limitations for use in supporting EPA risk management decisions. Two important deficiencies associated with the overall risk characterization approach are the absence of (1) clearly defined quality criteria established for each type of data element and (2) a technically defensible and transparent process for quantifying the impact of uncertainty (and variability) on final risk modeling results.

The preliminary screening approach (Phase IA) used to quantify the risks associated with the air inhalation pathway, groundwater to surface water pathway and the indirect exposure pathway effectively eliminated those constituents that represented insignificant risks. However, as the risk characterization analysis progressed from the risk screening to the release assessment and risk-modeling phases, the methodology lacked the transparency required to fully evaluate the accuracy of the final risk results. Moreover, the EPA's decision to conduct a probabilistic risk assessment for the groundwater exposure pathway and not for the other contaminant exposure pathways including air inhalation, groundwater to surface water and indirect exposure pathway is difficult to understand given the EPA's extensive use of probabilistic modeling in other regulatory programs (e.g., Hazardous Air Pollutants Residual Risk Program – EPA-453/R-99-001).

EPA used screening models, including the industrial waste air model (IWAIR) and the industrial waste exposure model (IWEM), to calculate screening risk estimates associated with the air inhalation and groundwater surface impoundment exposure pathways. Each of these models, in turn, depends on the output from other models. For example, IWAIR is a deterministic model that utilizes:

- a) the output from the CHEMDAT8 volatile emission model to calculate the constituent release (*i.e.*, emission rate) from an impoundment,
- b) the dispersion factors developed from the Industrial Source Complex Short Term (ISCST3) model to calculate an air concentration, and
- c) EPA risk assessment guidance to conduct an exposure and risk calculation.

The Subcommittee supports the EPA's decision to assign standard EPA exposure factors to specific parameter values (*e.g.*, inhalation rate, body weight, exposure duration, *etc.*) for quantifying long-term chronic health risk. However, because specific environmental and facility management factors (*e.g.*, contaminant concentration, level of aeration, pH, wind speed, temperature, *etc.*) can have a significant effect on contaminant emission rates, the Subcommittee encourages the EPA to quantitatively evaluate the sensitivity of the CHEMDAT8 model output to changes in the values of input parameters. Moreover, for those parameters identified to have a significant impact of CHEMDAT8 model output, the EPA should consider capturing and propagating the uncertainty associated with those parameters with the risk assessment methodology through the development of probability distributions.

The IWEM model employs a Monte Carlo probabilistic approach to develop statistical distributions of various parameters that impact the fate and transport of contaminants associated with the groundwater exposure pathway. Once the probabilistic distributions are assigned, the IWEM model employs the EPA Composite Model Leachate Migration with Transformation Products model (EPACMTP) to compute the groundwater monitoring well concentration and the dilution attenuation factor (DAF) at 150 meters from the source along the centerline of the plume. Three two-parameter probability statistical distributions (gamma, lognormal and Weibull) were used to model the distribution of values of critical parameter values used in the groundwater pathway simulation.

Although the Subcommittee supports the EPA's use of a probabilistic approach for characterizing the risks associated with the groundwater exposure pathway, a detailed review of its implementation was not conducted because a detailed description of the methodology was not provided. Specifically, the risk assessment methodology described neither the process used to select those groundwater fate and transport parameters to be modeled probabilistically nor how the shape of the distributions were determined. Furthermore, for those parameters that were modeled probabilistically, the EPA should provide explicit descriptions of (1) how functional dependencies of input parameters were modeled and (2) the technical process for determining the locations for probability distribution truncation. Finally, because of the importance in direction of groundwater flow

1 in characterizing risk associated with the groundwater exposure pathway, the  
2 Subcommittee encourages the EPA to provide a transparent and detailed description of  
3 the process used by experts to assign flow direction and how the uncertainty associated  
4 with “professional judgment” was captured in the final risk modeling results.

5 The indirect exposure pathway analysis considered a set of exposure pathways,  
6 each linked to a specific release scenario and receptor population. For example, the  
7 human health risks associated with indirect contaminant exposures associated with  
8 contaminant volatilization, particle entrainment, erosion/runoff and groundwater to surface  
9 water recharge were evaluated using a set of facility specific and environmental setting  
10 criteria, which serve as input parameter values in a risk ranking algorithm. The ranking  
11 algorithm was used to generate and overall ranking for the specific exposure pathway.

12 The ranking algorithm used a process of assigning arbitrarily established risk  
13 criteria values using surrogate data that ranged from (1) to (3) with (1) representing lower  
14 risk facility specific or environmental setting conditions, (2) representing intermediate  
15 conditions and (3) representing higher risk conditions. The risk criteria were summed to  
16 rank the importance of specific exposure pathways for indirect exposure for each facility-  
17 impoundment combination. Facilities were placed in an appropriate “bin” reflecting the  
18 magnitude of their indirect exposure risk.

19 The Subcommittee encourages the EPA to eliminate the use of binning to identify  
20 and characterize indirect exposure high-risk surface impoundments. The principal  
21 concerns associated with the use of binning are that the method is not only inherently  
22 biased and uncertain but the risk results may reflect a level of accuracy that does not exist  
23 and could be misinterpreted and/or misapplied.

24 Human health risks may not be adequately characterized. Because of the large  
25 uncertainties and omissions, the quantitative estimates of risk do not appear reliable. In  
26 assessing potential health effects, EPA did not explore plausible alternative assumptions.  
27 The uncertainties in the health parameters and associated with the presumed endpoints  
28 affected are not well described.

### 29 **3.1.3.2 Ecological Risks**

30 In addressing the elements of this charge question, the Subcommittee found:  
31

- 32 a) The ecological risk assessment is generally explicit in describing the  
33 assessment approach, assumptions, and extrapolations.

- 1           b)     Explicit, plausible, alternative assumptions were not really relevant to the  
2                 ecological screening analysis
- 3           c)     The ecological risk assessment does not directly identify many of the data  
4                 gaps. The only factor mentioned under data gaps is the lack of data  
5                 available to develop screening concentrations for many chemicals (p. 3-46).  
6                 However, EPA recognizes elsewhere (e.g., in discussions of uncertainty),  
7                 that numerous data gaps exist in both the characterization of exposure  
8                 (relevant abiotic media concentrations, uptake factors) and the  
9                 characterization of effects, particularly related to toxicity of soil/sludge. This  
10                question is also addressed in the response to question 3a on research  
11                priorities.
- 12          d)     EPA does a good job of distinguishing science from policy. For example,  
13                 EPA translates the terms A human health and A the environment from the  
14                 study purpose as described in the LDPFA and the consent decree (p. 1-8)  
15                 into very specific human health and ecological endpoints and assumptions.
- 16          f)     The risk assessment results are explicit in qualitative descriptions of  
17                 uncertainty, but not quantitative characterizations of uncertainty. Quantitative  
18                 estimates of uncertainty would be preferable, where possible, particularly if a  
19                 more definitive ecological risk assessment is performed [Guiding Principles  
20                 for Monte Carlo Analysis EPA/630/R-97/001, Summary Report for the  
21                 Workshop on Monte Carlo Analysis EPA/630/R-96/010].

22                The Subcommittee commends the EPA for appropriately recognizing that  
23                the ecological risk characterization and indirect pathway risk  
24                characterization are less certain than the characterization of [human health]  
25                risks via air, groundwater, and groundwater to surface water (p. ES-3). The  
26                high level of uncertainty associated with the screening ecological risk  
27                assessment is also acknowledged in Sect. 3.5.2.1 (p. 3-43). This degree of  
28                uncertainty applies to those facilities identified as having a potential for  
29                ecological risk (including those of a lower concern). Screening-level risk  
30                assessments rarely have false negative results, and there is no evidence that  
31                this ecological assessment lacks conservatism, so facilities that are  
32                screened out as having the least potential for risk are almost certainly not of  
33                concern.

34                The discussion of uncertainties associated with the ecological risk  
35                assessment in Sect. 3.5.3 and Sect. C.1.9.2 are generally thorough, and the  
36                distinction of uncertainties as parameter uncertainties, modeling

1           uncertainties, and results uncertainties is useful. Under Sect. 3.5.3.1,  
2           Assumptions on Dietary Exposure, the Subcommittee recommends that the  
3           EPA discuss the uncertainty associated with uptake factors for wildlife  
4           foods. When compared to values from national-scale studies (e.g., BJC  
5           1998), the uptake factors selected for several inorganic chemicals do not  
6           seem conservative, and are highly uncertain. Under Sect. 3.5.3.2, Constant  
7           Chemical Concentration, the Subcommittee suggests that EPA explain why  
8           a constant chemical concentration will tend to overpredict the potential risks  
9           to wildlife. Under Sect. 3.5.3.2, single chemical exposures, the  
10          Subcommittee suggests that EPA explain the potential for possible multiple  
11          chemical effects and the likelihood (based on existing literature) that toxicity  
12          of multiple chemicals is additive, less than additive or synergistic.

- 13          g)     The Subcommittee found the question about describing the relative strength  
14                  of the assessment somewhat vague. Obviously, conclusions from a refined  
15                  ecological risk assessment are more accurate than those from a screening-  
16                  level risk assessment. Therefore, EPA is unable to make strong conclusions  
17                  related to ecological risks. Few facilities and chemicals are screened out;  
18                  this could mean either that surface impoundments have high potential for  
19                  ecological risk or that the assessment is weak in not recognizing a low risk  
20                  potential.

22           **3.1.4 Please provide your assessment of the accuracy of EPA's overall**  
23           **study conclusions regarding risk to human health and the**  
24           **environment. Were the conclusions either false positive or false**  
25           **negative conclusions (finding risks of greater or lesser magnitude**  
26           **that the risks that likely exist)?**

27           **3.1.4.1 Human Health Risks**

28           In general, the Subcommittee supports the level of accuracy associated with the  
29           screening level risk characterization. The use of conservative assumptions minimized the  
30           elimination of surface impoundments that could potentially represent significant risks to  
31           human health and the environment. The Subcommittee supports the EPA's decision to  
32           adopt conservative assumptions within the risk characterization process that will  
33           overestimate the risk and thus provide greater protection to public health and the  
34           environment. However, in many instances, potentially important contaminant fate and  
35           transport pathways (e.g., groundwater colloidal and fracture flow, exposure of groundwater  
36           contaminants through inhalation, etc.) were not addressed within the risk assessment  
37           methodology. The Subcommittee encourages the EPA to evaluate the uncertainty

1 associated with final surface impoundment risk results when these specific pathways are  
2 neglected.

3 With respect to the contaminant release assessment and risk modeling  
4 methodologies, the absence of established data quality criteria and quantitative estimates  
5 of risk uncertainty limited the ability to effectively evaluate the accuracy of the final risk  
6 estimates. The Subcommittee recommends that the EPA provide greater transparency in  
7 its description of both the types and quality of data used to support the contaminant  
8 release assessment and risk modeling efforts.

9 There are a number of biases in the methodology used to estimate health risk  
10 contributing to false negative conclusions. These include the limited chemical selection,  
11 endpoint selection, assignment of zero potency and hazard for specific chemicals and  
12 routes in the absence of readily available indicators. As one example, from tables in  
13 Appendix C it appears that numerous chemicals were presumed to pose no cancer risk by  
14 any route (e.g., cobalt compounds, glyceraldehydes, lead, 1,4-dioxane, styrene oxide,  
15 styrene, naphthalene, and numerous others) or no risk by a given route (i.e., various  
16 Polycyclic aromatic hydrocarbons, dimethylbenzidine, dimethoxybenzidine,  
17 pentachloronitrobenzene, hexavalent chromium, 1,3-butadiene, and numerous others) even  
18 though there are data suggesting other hypotheses are plausible. Other Appendix tables  
19 indicate that a number of non-cancer effects were overlooked for specific chemicals.

#### 20 **3.1.4.2 Ecological Risks**

21 The study results for ecological risk assessment are accurate in the sense that the  
22 range of potential risks that is described encompasses all of the likely risks. However, as  
23 with most screening-level risk assessments, many of the potential risks are likely to be  
24 false positive conclusions, and the fraction of potential risks remaining at the conclusion of  
25 the ecological risk assessment is high.

26 A major concern, however, is that summaries and conclusions state that only 29%  
27 of the facilities had potential ecological risks. Because EPA's definition of potential risk  
28 (i.e., facilities with potential risk for which more than 38 receptor exceedances were  
29 observed, p. C-46) is much narrower than the literal definition of potential risk, a large  
30 fraction of potentially risky facilities is excluded, leading to possible false negative  
31 conclusions. Approximately 92% of facilities have potential ecological risk when using a  
32 literal definition of potential risk.

### 33 **3.2 Charge #2: Abnormal Operating Conditions – Should EPA have performed a** 34 **more in-depth evaluation of abnormal operating condition events?, If so,** 35 **what methods or approaches would the SAB recommend regarding**

**collecting more reliable data, and modeling the probability and impacts of such events?**

The term “abnormal operating conditions” is not explicitly defined in Industrial Surface Impoundments in the United States. The Subcommittee defines this term as operating conditions involving changes in wastewater characteristics, severe weather or structural failure of one or more critical components of the surface impoundment. Abnormal operating conditions can influence the magnitudes of the source term concentrations of contaminants and hence, impact upon the rates at which contaminants migrate from the impoundment into the ambient environment.

In responding to this charge question, the Subcommittee addressed: completeness of the list of abnormal operating scenarios used by the EPA for risk assessment; the effects of non-consideration of relevant factors and scenarios on computed risk estimates; and the approach (es) that the EPA may adopt to incorporate factors and scenarios that are not presently covered by the current risk assessment methodology.

The internal zonation of the constituents of a surface impoundment may also be a factor in the release potential of contaminants under abnormal operating conditions. Impoundments usually consists of an active zone comprising the bulk of the volume of the containment, a sludge zone of minimal volume and contaminated liner or soil at the base. An abnormal operating condition of sufficient intensity can affect the processes and flow of contaminants out of one or more of the zones.

The EPA has adopted two complementary approaches to estimating both ecological and human health risks posed by surface impoundments. In one approach, monitoring data are used to determine contaminant source terms. In another approach, source terms are estimated using models and judgment for use in predicting future risk. Although it may be necessary for the EPA to determine how abnormal operating conditions may have affected the monitoring data collected in the first approach, it is not necessary for the EPA to modify the data on considerations of abnormal operating conditions. The effects of these conditions are already reflected in the monitoring data. The second approach involves predictions of impoundment performance in the future and the impact of abnormal operating conditions on source terms and future human health and ecological risks. For this approach, it is important that the impacts of abnormal operating conditions be analyzed and incorporated into the estimates of risk. This is the focus of the recommendations presented here in response to charge question # 2.

Developing and integrating probabilistic analysis of the potential impacts of transient events into an analysis designed to produce a single risk number is challenging. Understandably, the technical difficulty of the task and its unfamiliarity may have

discouraged the EPA from covering transient events in the risk assessments. Nevertheless, in the long term, EPA needs to undertake full-fledged rational analyses of transient events to support decision-making on issues such as surface impoundments.

In the meantime, EPA could still assess the history and prospects of significant impacts of abnormal operational conditions on releases and emissions from impoundments. The data already developed in tier 2 of the EPA study provide a basis for assessing the current and potential impacts of transient events on human health and the environment in various regions of the United States. Such an analysis would rely on the collected location and monitoring data, augmented with additional data from studies of other types of impoundments, such as those in the mining and agricultural sectors. First, impoundment performance information would provide the basis to assess the pattern of failures. Then statistical analyses could elucidate whether impoundments with similar locational, design and operational characteristics do pose and/or could pose significant risks to public health and the environment. The Subcommittee suggests this type of analysis would provide an adequate national level risk assessment.

When data on numerous parameters of specific, or existing hypothetical impoundments become available, then probabilistic models can be used to provide a better understanding of the risks. Until then, the results of the study's tier 3 assessments would be de-emphasized in drawing conclusions about risks because they do not include this important element of risk. However, elements of tier 3 analyses where necessary and appropriate would be used to support conclusions that are primarily based on tier 2 analyses.

The following sections provide more detailed but direct assessments on the extent to which EPA addressed transient events in its risk analyses. The Subcommittee also recommends ways to address transient events in risk assessments when/if the context and intended purpose of the relevant program warrants more detailed quantitative risk assessments.

### **3.2.1 Types of Abnormal Operating Conditions and the Necessity to Address Them.**

For the design categories, locations and management systems of the impoundments described in this study, the Subcommittee has determined that the abnormal operating conditions described below should be considered in the analysis of risks associated with the performance of impoundments.

#### **3.2.1.1 Changes in wastewater characteristics.**

Wastewater that enters an impoundment may undergo major changes in characteristics due to accidental spills or changes in production practices. Possible manifestations of these changes are changes in pH (that could still be within the acceptable range for non-hazardous wastes), and release of chelating agents or fine particulates. Metals can be solubilized as a result of pH changes, with a consequent decrease in their breakthrough times as they travel through the liner of an impoundment. Direct chemical attack of liner materials under aggressive pH conditions is also a possibility. The release of chelating agents can also lead to an increase in the concentration of metals in the effluent and possibly, increased breakthrough of metals through the liner. Fine particulates settle very slowly in aqueous media and can mobilize contaminants through adsorption and / or ion exchange mechanisms into the effluent. These phenomena are not addressed in the modeling effort described in the document. The risks associated with these phenomena should be accounted for raise it as an issue and appropriate safety factors incorporated in the predictive methodologies, if necessary.

#### **3.2.1.2 Storm events**

Industrial Surface Impoundments in the United States stated that most surface impoundments receive stormwater. Increased flow of water into an impoundment due to a storm event can, in addition to causing the release of poorly managed wastewater, scour the sludge zone of the impoundment and discharge elevated concentrations of contaminants from the sludge zone. For example, an intense storm can wash out previously settled contaminants from the sludge zone. The Subcommittee recommends that watershed modeling approaches that incorporate high-impact storms of appropriate return periods be integrated into the methodology to address risks associated with stormwater influx into impoundments. The EPA should also collect empirical information from the regions on surface impoundment failures during the past 10-20 years. Some case-histories may be available on impoundment failures due to storms in North Carolina and Colorado. Such information may be useful for calibrating facility failure and contaminant transport models.

#### **3.2.1.3 Structural failure due to seismic events**

Seismic events such as earthquakes can threaten the structural integrity of impoundments. A confining berm or dyke could fail due to ground shaking in earthquake-prone regions. Such failures would cause an immediate release of contaminants into the subsurface or over land. The Subcommittee has noticed the absence of seismic considerations in Table 4.4. An assessment of the design and geographic distribution of impoundments vis-à-vis earthquake zones is necessary to establish the risk of catastrophic failures within the timeframes of concern. This is particularly important because the period of coverage of the risk analysis is as long as 10,000 years.



### **3.2.2 Adequacy of the Methodology used to Analyze Risks Posed by Surface Impoundments**

Except for not addressing abnormal operating conditions, the EPA has done an excellent job of linking numerous factors to estimate both human health and ecological risks posed by surface impoundments. The Subcommittee particularly notes that EPA had gathered, disaggregated and analyzed data on several impoundment characteristics to establish how impoundments have performed during and after their service lives.

However, adequate data may not be available for detailed quantitative assessments of all relevant scenarios using the EPA's approach. Other informative analyses are possible that do not focus on developing an exclusively quantitative risk profile. Therefore, the Subcommittee suggests that EPA adopt a more empirical analysis of data and develop conclusions on national risk profiles based mostly on the tier 2 analyses.

Abnormal operating conditions influence the magnitudes of the contaminant source concentration terms. Source term concentration estimates need to be reasonably accurate because they are input data to models used for contaminant migration and risk assessment. Indeed the EPA acknowledges the criticality of source terms by stating (page C-13), "one of the most sensitive parameters in risk modeling is the source concentration term. Frequently, this term is associated with a high level of uncertainty because (1) the data on concentration may not be sufficient to characterize the variability due to changing waste streams, impoundment conditions, and other characteristics; and (2) the analytical methods may be insufficient to quantify the concentration term...". In the second paragraph of Appendix page C-93 of the document, the EPA further states that "the release of contaminants into the subsurface constitutes the source term for the groundwater fate and transport model. Because the modeled subsurface fate and transport processes are the same for each waste management scenario, the conceptual differences between different waste management scenarios are reflected solely in how the model source term is characterized."

The Subcommittee agrees with the EPA on the importance of source term characterization. Therefore, the Subcommittee suggests it would be useful for EPA to assess and report on how the selected risk assessment framework covers the effects of abnormal operating conditions on contaminant source terms and hence risk estimates. Such factors should be considered in drawing conclusions about risks in cases that warrant full-fledged risk assessments.

Except for the case of changes in wastewater characteristics, the Subcommittee does not advocate a generic modification of contaminant concentration source terms to

1 accommodate the impacts of transient events in the risk assessments. Instead, the  
2 analysis should be done on region-by-region basis because specific regions of the United  
3 States have transient events of significant magnitudes at elevated frequencies. As  
4 examples, earthquakes are prevalent in the West Coast and Central USA, while storms /  
5 floods are more frequent in the Southeast and Midwest. These high hazard zones overlap  
6 areas with high concentrations of impoundments. Figure 1 (designated as Figure 2-2 on  
7 page 2.4 of Industrial Surface Impoundments in the United States) shows that there are  
8 1035 impoundments in the West Coast, 434 in Alaska and 601 in Hawaii where seismic  
9 events are relatively frequent; and 4103 impoundments in the Southeast where annual  
10 precipitation and storm frequencies are relatively high.

11 EPA used the EPACMTP model to perform contaminant fate and transport analysis  
12 for risk modeling; the model is reasonably adequate provided input data are appropriate.  
13 The mathematical architecture of this model was previously reviewed by the USEPA  
14 Science Advisory Board. The model is appropriate for use in performing fate and transport  
15 analyses but not for generating a contaminant release source term from multi-component  
16 constructed facilities like surface impoundments. The Subcommittee notes that  
17 contaminant source term concentrations need to be determined either through the use of  
18 monitoring data or predictions of contaminant release rates / events using containment  
19 system failure / liner permeation models, for input into the risk models. As indicated by the  
20 EPA in Figure 2. (designated as Figure 3.1 on page 3.3 of Industrial Surface  
21 Impoundments in the United States), the release scenarios that are considered to impact  
22 upon source terms are volatilization / dispersion, leaching and erosion / run off. Analyses  
23 are likely to show that for some impoundments located in the regions mentioned in the  
24 preceding paragraph, this suite of release scenarios is incomplete. Furthermore, the  
25 EPACMTP does not model the impacts of transient events and this should be stated under  
26 “model simplifications” on page 3-18 of the Industrial Surface Impoundments in the United  
27 States .

28 On page 3-18, Industrial Surface Impoundments in the United States stated that “the  
29 risk to receptors for the groundwater pathway was evaluated over a time period of 10,000  
30 years”. This timeframe is long enough for the occurrence of very high–impact storms and  
31 seismic events at least in the active regions identified. Furthermore, most components of  
32 surface impoundments would have deteriorated to ineffective levels of performance within  
33 200 years unless they are maintained or re-built. This does not imply that the service life of  
34 impoundments is 200 years. The actual service life depends on facility design, facility  
35 location, operational conditions including the impact of transient events, and the types of  
36 wastes impounded. Although contaminant arrival at reception locations can trail releases  
37 from facilities by several decades, it is necessary to conduct a general assessment of the  
38 need to account for the presence of liners in scenarios where long exposure timeframes  
39 are considered.

### 3.2.3 Data Needs for More Adequate Treatment of Abnormal Operating Conditions

The EPA has collected a significant amount of valuable data on surface impoundments. On the assessments that it has conducted regarding the performance of impoundments, it has done a reasonably thorough job. To perform additional assessments, EPA should conduct additional analyses using the existing data with additional regional data most of which can be collected from public agencies. For example, impoundment overtopping failures due to storms are known to have occurred in the Carolinas. Relevant information from that region may help in establishing the pattern of failures.

The EPA has already collected facility design and contents data. It has also supplemented these data with synthetic data estimated using empirical information developed by several researchers. In the bottom paragraph of page 1-1, the EPA acknowledges that it performed a comprehensive census of agricultural, mining, industrial and municipal surface impoundments in the late 1970s and the early 1980s, including characterization of about 30,000 impoundments with respect to their geographic distribution, sizes, functions and potential for groundwater contamination. Unfortunately, the EPA notes that these data were not used to support the analysis presented in Industrial Surface Impoundments in the United States because they were not available. The information to which reference is made above may be useful in determining the pattern of impoundment performance, especially, if a significant number of the impoundments characterized are located in high hazard zones.

Hazard zonation information is needed. For a significant number of impoundments, the EPA already has the information needed to address possible changes in wastewater characteristics. Where site-specific data are needed, the EPA can use ranges of synthetic data drawn from the realm of experience in the magnitudes of transient events that have occurred / or are likely to occur in the region as well as the predominant geotechnical characteristics of sites in the region. In the case of overtopping due to storms, there may be useful information in the regions, especially in North and South Carolina. Incidentally, the EPA has collected and used relevant data in Industrial Surface Impoundments in the United States for a different purpose. In section A.3.1.3 of page A-28, the EPA acknowledges that it used GIS to screen information on sites for the purpose of performing ecological risk modeling. The spatial relationships between each impoundment site and the following factors were considered: managed areas, landuse categories, permanently flooded woodlands, Bailey's ecoregions, fishable water bodies, soils and groundwater geology. Among the resources used for information were regional geologic maps, state soil survey maps and watershed maps. These data and resources need to be used again to analyze the potential impacts of storms / floods and seismic activities on contaminant

1 source terms. Ground acceleration (seismic) maps of high seismic hazard zones are  
2 obtainable from the U.S. Geological Survey while flood frequency maps are available at  
3 the Federal Emergency Management EPA.

4 For detailed probabilistic treatment of the impact of transient events on risks posed  
5 by surface impoundments (which is not necessary to draw the conclusions sought in this  
6 study), event frequency maps alone are not adequate for use in predicting impoundment  
7 failures due to transient events. Such frequency maps are generally used to address  
8 geohazards risks that define the magnitudes and associated return periods of stressing  
9 events. The spectra of expected stresses within the period of consideration (in this case  
10 up to 10,000 years) would then be used to analyze the reliability of the most common  
11 designs and expected (probable) releases. This type of analysis feeds into the exposure  
12 assessment and is quite commonly done in dam safety assessments. The focus of this  
13 category of analyses would be on specific designs of impoundments as required by Tier 3  
14 risk assessment, Relevant methodologies can be included in a technical guidance or  
15 resource document. It is not necessary to implement such detailed quantitative  
16 assessments of a very small percentage of impoundments (with high uncertainties) as a  
17 basis for drawing conclusions on natural risk profiles.

#### 18 **3.2.4 Recommendations on Approaches to Incorporating Assessments of** 19 **Abnormal Operating Conditions**

20 As indicated in the introductory part of section 3.2, the EPA should analyze data at  
21 the tier 2 level and collect more data, some from other regulatory programs that involve  
22 impoundments. EPA should base its conclusions on risks posed by abnormal operating  
23 conditions mostly on such data and their analyses.

24 The Tier 3 analyses are useful mostly for technical guidance. A useful approach to  
25 incorporating the effects of transient events and changes in wastewater characteristics on  
26 risks posed by surface impoundments is the estimation of likely changes in the magnitude  
27 of the contaminant concentration source term. If the impoundment fails catastrophically in  
28 the high hazard zone or becomes ineffective due to aggressive wastewater  
29 characteristics, there should be an increase in contaminant source term concentrations for  
30 the relevant pathways.

31 For the Tier 3 analyses involving traditional quantitative risk assessment, the  
32 challenge for the EPA, is the development of a scheme for estimating the magnitude and  
33 rate of increases in source terms in response to these abnormal operating conditions.  
34 Some suggestions on the approaches that the EPA may adopt to address the impacts of  
35 abnormal operating conditions on source terms are presented below for the tier 3  
36 assessment.

#### **3.2.4.1 The Factor of Safety Approach**

EPA may elect to apply empirical safety factors to source term concentrations in scenarios and zones of abnormal operating conditions; these are similar to the traditional approach used in structural design. Such factors, which would have the net effect of increasing the source term, should be directly proportional to the most probable intensity or magnitude of the event or phenomena within the timeframes and locations of interest. If available, historical data can be used to support the indexing system.

#### **3.2.4.2 The Zero Containment Assumption**

Under abnormal operating conditions that are of high intensity or frequency, the EPA may assume that the containment system will not exist after certain specified service timeframes. For the groundwater transport pathway, this is tantamount to the assumption that the contaminant source term at locations immediately around the impoundment are the same as the concentrations of the target contaminants within the impoundment. This should be considered to be a conservative assumption.

#### **3.2.4.3 Impoundment Degradation and Contaminant Release Modeling**

This approach involves a more systemic analysis of the response of components of the impoundment to various levels of stress imposed by the transient events or contaminant release/chemical attack by contents of the impoundment. Essentially, the analysis establishes a quantitative relationship between the degradation of the significant components of the containment over time, under the expected magnitude of the transient event. With increase in the permeability or hole size/density of the impoundment liner following a transient event, contaminant release rates would be high. Appropriate models can then be used to estimate the growth in the source term in response to the slow or abrupt increase in contaminant release volume. Probabilistic analyses of potential damages cannot be avoided if this approach is adopted. Relevant issues have been described by Bass et al. (1985), Iman et al. (1990), Inyang and Tumay (1995), Inyang (1994), Peterson (1990) and Inyang et al (1995)

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### 18 **3.3 Charge #3 Screening-level risk characterizations**

19 A screening-level risk assessment is generally intended to determine the scope of  
20 a definitive or higher-tier risk assessment by eliminating from further consideration  
21 chemicals, receptors, and/or facilities that are clearly not associated with a potential risk.  
22 EPA presented results from two screening-level analyses to determine the potential for risk  
23 to human health from indirect pathways and to determine the potential for ecological risk  
24 from all pathways considered. Indirect pathways for human exposure and ecological  
25 exposure were not considered in a more definitive risk assessment.

26 To investigate the risk of potential indirect exposures to human receptors through  
27 pathways such as ingestion of crops, dairy products and fish that might be contaminated  
28 through runoff from closed impoundments, or air dispersion onto nearby farmlands, EPA  
29 conducted a screening level risk characterization. In contrast to a formal risk assessment,  
30 this analysis consisted of a categorizing and ranking of exposure factors of potential  
31 concern for each facility in order to identify facilities where indirect pathways may be of  
32 potential concern.

1 In the first stage of the indirect screening, EPA reviewed the constituents reported  
2 in the surveys to identify a short list of bioaccumulative constituents for indirect exposure.  
3 The second stage of the screening analysis was to identify all facilities that reported  
4 managing these constituents and to screen these facilities according to their potential for  
5 indirect exposures. The criteria considered included size of the surface impoundment,  
6 distance from the impoundment to the nearest receptor, slope of the terrain in the vicinity of  
7 the site, and size of nearby water bodies. The rankings assigned to these facilities were  
8 based exclusively on an assessment of current site-conditions, including both  
9 impoundment status and environmental setting criteria in the vicinity of the facilities.  
10 However, a future closure scenario was also included in the analysis to address potential  
11 risks following impoundment closure.

12 Once the screening had been completed to identify facilities where indirect  
13 pathways were of potential concern, EPA generated national estimates of the proportion of  
14 facilities that could pose concerns due to indirect pathway exposures. The measures used  
15 were as follows:

- 16 a) *Potential Concern.* This risk metric is an indicator of the potential for  
17 completion of more than one indirect exposure pathway at the facility.
- 18 b) *Lower Concern.* This risk metric is an indicator of the potential for  
19 completion of one indirect exposure pathway at the facility and, therefore, of  
20 relatively lower concern.
- 21 c) *Least Concern.* This risk metric is an indicator of low potential to complete  
22 even one indirect exposure pathway at the facility.

23 Six percent of facilities fell into the potential concern category for indirect exposure.  
24 EPA found that the qualitative character of the indirect exposure pathway analysis led to  
25 several major areas of uncertainty that affected their interpretation of the results. EPA  
26 concluded this degree of uncertainty was acceptable for a first-pass assessment as to  
27 whether individual facilities have the potential for indirect exposure pathway risk. They  
28 found that the use of the screening methodology precludes drawing any conclusions  
29 regarding the potential magnitude of risk that these facilities could pose either now or in  
30 the future.

31 EPA conducted a screening-level risk characterization of potential ecological  
32 concerns. This assessment identified facilities where there could be ecological concerns  
33 provided there were direct contact and/or ingestion of surface impoundment contents by  
34 various ecological receptors, using conservative screening assumptions.

1           The ecological risk screening was similar to the first screening stage of the human  
2 health risk analysis, but did not go beyond that stage to consider actual exposures, and did  
3 not rely on fate and transport modeling. The assessment strategy was intended to  
4 represent only the potential for adverse ecological effects, not the actual risk posed to  
5 ecological receptors. Potential risk was assessed for numerous birds, mammals, and  
6 amphibians as well as for soil, aquatic, and sediment communities (e.g., earthworms, fish,  
7 and insect larvae). Aquatic and terrestrial plants were also assessed. EPA assigned  
8 receptors to each facility based on regional data sources and land use characteristics at  
9 each facility. The assessment compared chemical concentrations in surface impoundment  
10 water and sludge to concentrations that are considered protective. An additional element  
11 of the ecological screening analysis considered whether surface impoundments are  
12 located near sensitive ecosystems such as wetlands, wildlife refuges, or national forests.

13           In the final stage of the screening-level assessment EPA compared the number of  
14 each facility's risk exceedances to the median number of exceedances for all the facilities  
15 that did not screen out. Using this standard, facilities that exceeded screening levels were  
16 placed in two categories:

- 17           a)     *Potential concern.* Facilities having at least the median number of  
18           exceedance for ecological receptors (i.e., 38 or more exceedances).
- 19           b)     *Lower concern:* Facilities having fewer than the median number of  
20           exceedances for ecological receptors.

21           In addition, a *least concern* category indicated risk below the screening threshold.

22           EPA found that a total of 34 chemicals exceeded the risk criteria for at least one  
23 receptor at one impoundment, and 54 of the more than 62 ecological receptors  
24 considered showed potential risk exceedances. These receptor taxa include mammals,  
25 birds, and plants, as well as soil, aquatic, and sediment communities. Ninety-two percent  
26 of facilities exceeded risk thresholds for at least one receptor at one impoundment. EPA  
27 found that the screening nature of the analysis led to several major areas of uncertainty that  
28 affect interpretation of the results.

29           **3.3.1 Question 3 a: For the indirect human health and ecological**  
30           **screening-level analyses do the results point to areas of potential**  
31           **future research? If so, do you have recommendations on prioritizing**  
32           **future studies in these areas?**

1 Areas of potential future research are described in Sect. 3.7. These include  
2 research related to the indirect human health and ecological pathways, as well as other  
3 areas of uncertainty in the Surface Impoundments Study.

4 Maney asks, "SHOULD this section also include some recommendations from 3.1???"

5 **3.3.2. Question 3 b: Based on the screening-level estimates we developed**  
6 **for other indirect and ecological risks, did it appear that we**  
7 **overlooked potential problem areas?**

8 In general, potential indirect pathways were not overlooked. However, a more  
9 comprehensive indirect pathway risk assessment would assess effects of transient events,  
10 such as overtopping events or liner failures; indoor routes of exposure, such as volatile  
11 chemicals in home shower water or dishwashers; land application of industrial sludges;  
12 and potential use of contaminated water to irrigate crops. Similarly, in evaluating the  
13 screening-level estimates for indirect risks, an exploration of the impact of chemical  
14 selection and presumptions of hazard and potency for certain chemicals is needed.

15 The Subcommittee is uncomfortable with the approach used to categorize facilities  
16 where indirect pathways are a potential concern. The use of simple ranking categories to  
17 produce three equal-sized bins for some pathways may underestimate (or overestimate)  
18 the actual risk. (For example a designation of level 1 for Surface Area may still pose  
19 significant risk.) Therefore, the final ranking heading "Potential Concern" suggests more  
20 certainty than warranted. (See further discussion of terminology in Sect. 3.3.2.3 DFO to  
21 check this Section Number before report goes final.)

22 In general, potential problem areas related to ecological risk assessment were not  
23 overlooked. It would be useful to have more justification for the presumed negligible  
24 exposure of ecological receptors to air pollutants. If a more refined ecological risk  
25 assessment is performed, some consideration of the chronic exposure implications of  
26 overtopping events, flooding, dike failure, liner failure, etc. would be helpful.

27 EPA states that the EPA overlooked threatened and endangered species (p. C-  
28 160), but that is not really true. Given the conservative character of the screening  
29 ecological risk assessment, it should apply equally to most threatened and endangered  
30 and non-threatened individuals, unless there is reason to believe that these organisms are  
31 more sensitive than others. The only exception may be the amphibian and reptile  
32 populations for which reproductive data were not available.

33 In general, the terminology related to potential levels of risk was confusing, such that  
34 potential risks may have been overlooked in the conclusions of the study. In Sect. 3.3.2.3

DFO to check this Section Number before report goes final, the Subcommittee recommends a more objective approach to terminology related to potential risk.

### **3.3.3 Question 3 c: Did we clearly describe and properly characterize the other indirect human health and ecological risk analyses?**

Potential risks were appropriately analyzed in the screening-level analyses. For example, the suite of assessment endpoints and the criteria for their selection (p. C-160) were a strength of the assessment. The assessment clearly identified the pathways that were not considered in the ecological risk assessment (dermal and inhalation), explained that risks to populations were inferred from risks to individuals, and described how risks to plant and invertebrate communities were inferred. However, results were not always presented clearly.

Several points of clarification would be helpful.

- a) The biotransformation of mercury to methyl mercury, as well as other biophysical and photochemical transformations were not explicitly addressed in the risk assessment. This should be stated in the text.
- b) Only chemicals that bioaccumulate were considered for the indirect exposure pathway. How was it determined if a chemical can bioaccumulate (p. C-135)?
- c) Volatilization was considered only for the chemicals that “have the potential to volatilize.” How was this potential determined (p. C-138)? (Vapor pressure greater than some number?) Under the 1990 Clean Air Act Amendments (1990 CAAA), a VOC is defined as an organic compound that participates in the formation of ground level ozone.
- d) Cut-off points for volatilization (< 250 m, 250-500 m, >500 m) and particulate entrainment (>300m, 150-300 m, <150 m) were based on “significant changes” in the modeling results reviewed (p. C-142). This threshold needs better definition.
- e) The statement on p. 3-41 “The ecological screening assessment is precautionary because it is based on direct ingestion or uptake of the surface impoundment influent” is somewhat misleading. A similar statement is made on p. C-162. The risk assessment for vertebrates is based on dietary uptake of foods that have accumulated chemicals from the SI, and direct ingestion of sludge/soil and water from the SI. For plants and soil

1                   invertebrates, the risk assessment is based on direct contact with the  
2                   sludge/soil.

3                   In general, the methodology for the ecological risk analysis was presented well, but  
4                   results could be clearer, and the definition of terms could be improved in some cases. The  
5                   use of the terms “potential concern” and “lower concern” is not easily understood. Although  
6                   the terms are defined for the ecological risk assessment on p. 3-42 and for the “other  
7                   indirect pathways” assessment on p. 3-36, their definitions are not intuitive or literal. All  
8                   facilities with ecological risk exceedances are, in reality, of “potential concern.” Similarly,  
9                   all facilities with potential for completion of at least one indirect exposure pathway are of  
10                  “potential concern,” in contrast to the definition on p. 3-36.

11                  The Subcommittee recommends that the conclusions of the screening-level risk  
12                  assessments be presented in one of two formats. One distinction would be between the  
13                  percentage of facilities with “potential risk” and those with “risk below threshold of  
14                  concern.” If the EPA desires to categorize further facilities presenting potential risk, we  
15                  recommend that they do so in a literal manner (e.g., “potential risk from 2 or more  
16                  pathways”) rather than using subjective adverb descriptors that appear to quantify risk  
17                  more than the results allow.

18                  The conclusion that “these constituents and impoundments do not pose significant  
19                  risks to . . . the environment” (Sect. 3.6, 2<sup>nd</sup> para) is not supported by the screening-level  
20                  ecological risk assessment. Similarly, the conclusion that “Based only on this initial  
21                  screening level analysis and using precautionary assumptions, no more than 29 percent of  
22                  facilities nationally may pose potential concerns to ecological receptors that live near, or  
23                  make direct use of, surface impoundments” (top of p. 3-49) is not supported by the risk  
24                  assessment if the reader uses the literal definition of “potential.” In fact, these statements  
25                  conflict with the statement on p. C-47 that “the majority of facilities have some potential for  
26                  adverse ecological effects.” Facilities with less than 38 receptor exceedances across  
27                  facilities still have potential for risk, according to this assessment. EPA will be able to to  
28                  clarify these points using the altered terminology related to potential risks recommended  
29                  above.

30                  One point that is not made very clearly is that almost all facilities (92%, Table 3-24)  
31                  pass through the screening-level risk assessment (which is not consistent with the  
32                  statement that “29 percent of facilities may have localized ecological impact during their  
33                  operation or after closure,” p. ES-6). Only 8% of facilities are eliminated from concern in  
34                  the screening assessment. This makes the reader think that either 1) surface  
35                  impoundments have a high potential for ecological risk or 2) exposure or effects  
36                  assumptions were too conservative to be useful. In any case, the fact that the vast majority  
37                  of surface impoundments pose potential ecological risk should be stated more clearly in

the executive summary, perhaps with caveats that a definitive, quantitative assessment has not been performed.

Terms such as “facility risk,” “surface impoundment risk” and “constituent risk,” that are defined on p. C-177 are not quite clear. For example, we believe that facility risk consists of the sum of hazard quotients of multiple chemicals across one receptor at one facility, but the role of chemical constituents in the definition is not discussed.

### 3.3.4 Question 3 – Summary

In summary, the methodologies for the screening-level risk characterizations were, for the most part, clearly presented. However, the Subcommittee recommends that EPA:

- a) reevaluate the use of binning for ranking facilities that may represent a significant indirect exposure risk,
- b) better define the technical terms used to differentiate risk levels above and below thresholds,
- c) better characterize ecological exposure in the screening or in a more detailed risk assessment, and
- d) better characterize and ultimately reduce uncertainty in exposure (e.g., chemical transformation) and effects through additional secondary data-gathering and research.

### References

BJC (Bechtel Jacobs Company). 1998. *Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants*. BJC/OR-133. U. S. Department of Energy, Oak Ridge, TN. <http://www.esd.ornl.gov/programs/ecorisk/ecorisk.html> (Regressions and uptake factors have been peer-reviewed and will be appearing in Efroymson, R. A., B. E. Sample, and G. W. Suter II. 2001. Bioaccumulation of inorganic chemicals from soil by plants: regressions of field data. *Environ. Toxicol. Chem.*20(11):\*\*\*. in press.)

Sample, B. E. and C. A. Arenal. 1999. Allometric models for interspecies extrapolation for wildlife toxicity data. *Bull. Environ. Contam. Toxicol.* 62:653-663.

### 3.4 Charge #4 Survey Data on Chemical Constituent Presence/Quantity

**3.4.1 Please comment on the appropriateness of the application of the Agency's data processing and analysis protocols for ensuring consistency in interpreting survey data on a specific constituent's presence in an impoundment, or that constituent's quantity.**

The EPA used data processing and analysis protocols to ensure consistency in interpreting survey data on a specific constituent's presence or quantity in an impoundment. Sections A.4.2.1 and A.4.2.2 in Appendix A to Industrial Surface Impoundments in the United States describe the various processes and protocols employed to interpret non-detect data reported with a detection limit, non-detect data reported without a detection limit, present but quantity unknown (PQU) data and missing sludge data.

Regarding the appropriateness of the EPA's data processing and analytical analysis protocols and presentation techniques as they apply to the use of surrogate data, the Subcommittee found:

- a) The EPA designed a structured data process and structured protocols for dealing with surrogate data that consists of detection limit look-up tables, a decision tree for imputing non-reported quantities and an algorithm for calculating sludge concentrations. As described, this structured approach combined with the quality assurance step of double data-entry are appropriate for the incomplete survey data and will ensure that similar data gaps will be addressed in a consistent manner.
- b) The consistency of outputs from these data processes and protocols and how the EPA interprets survey information to generate the resulting surrogate datum can vary from contaminant to contaminant. For example, the detection limit look-up table for one contaminant lists a method detection limit while a quantitation limit is listed for another contaminant. Furthermore, the outputs from the data processes and protocols vary according to the proximity of a similar impoundment that has reported data. That is the surrogate concentration may be taken from a similar functioning impoundment at the same facility or a different facility with the same 2 digit industry group. Please refer to the following specific charge sections 3.4.4 and 3.4.7.

**3.4.2 Please comment on the appropriateness of the application of the EPA's analysis methods and presentation techniques to distinguish and explain the various degrees of certainty in the findings.**

1        Industrial Surface Impoundments in the United States clearly recognizes and  
2 discusses the reality of uncertainty when undertaking a nationwide study and when inferring  
3 from a limited database consisting of data of varying quality and completeness. EPA also  
4 used analysis methods and presentation techniques to help distinguish and explain the  
5 various degrees of uncertainty in the findings.

6        Regarding the appropriateness of the analysis methods and presentation  
7 techniques for uncertainty as they apply to the use of surrogate data, the Subcommittee  
8 found:

- 9        a)        That the discussions of uncertainty are qualitative and lacking quantitative  
10 criteria and ranges of potential uncertainty. Qualitative statements are made  
11 about the quality of the modeling results as a function of the quality of the  
12 concentration data reported in the survey. For example, on page 3-5 we find  
13 “EPA is most confident in those (concentration) data where respondents  
14 reported a value above a limit of detection and far less confident in other  
15 values, such as values less than detection limits.” If concentrations were  
16 reported in the survey, then “... EPA considers these data to have a  
17 reasonable degree of certainty” (quote from page 3-6). These types of  
18 statements are necessary but not sufficient to describe and explain the  
19 various degrees of certainty.
- 20        b)        Determining the sensitivity of risk estimates to concentration data would  
21 assist in evaluating the impact of surrogate data: The sensitivity of risk  
22 estimates to various assumed uncertainties in concentration data could be  
23 obtained using Monte Carlo simulations. The uncertainty in the  
24 concentration data would need to be characterized as carefully selected and  
25 realistic probability distributions that are used as input to the simulations.  
26 The results of the sensitivity analyses should indicate whether additional  
27 work is needed to reduce the uncertainty of survey concentration data in  
28 order to achieve suitably certain risk estimates. All of this assumes the  
29 required certainty of risk estimates is established, something that was not  
30 done for this study.

31        **3.4.3 Please comment on the degree of clarity of the risk results**  
32        **presentation, in the situations when surrogate data and detection**  
33        **limit data are employed.**

34        Industrial Surface Impoundments in the United States gives risk results for two  
35 cases: 1) when the direct pathway releases and risks are estimated using contaminant  
36 concentration values reported in survey forms, and 2) when those release and risk

estimates are based on surrogate and detection limit data. This distinction is made repeatedly within the report's executive summary, the body of the report, tables and appendices.

Regarding the clarity of Industrial Surface Impoundments in the United States in presenting risk results, when surrogate data and detection limit data were employed, the Subcommittee found:

- a) For air, groundwater and surface water pathways Industrial Surface Impoundments in the United States consistently discriminates between the releases and risks estimated using contaminant concentration values reported in survey forms and those release and risk estimates based on surrogate and detection limit data. Release and risk results are presented separately for surrogate/detection limit waste concentrations. Conducting separate screening risk assessments for reported data and for surrogate/detection limit data is laudable.
- b) The method used to obtain release and risk results when surrogate data and detection limit data were employed was clearly explained.
- c) The clarity of this discrimination between reported and surrogate/detection limit data suffers from mislabeling of tables (e.g., Tables C.1-16 and C.1-17). The related text refers to "groundwater pathway", Table C.1-16 refers to "Groundwater to Surface Water pathway" and Table C.1.17 refers to "Surface Water Pathway".
- d) For ecological risks, Industrial Surface Impoundments in the United States does not but should discriminate between the levels of concern estimated using contaminant concentration values reported in survey forms and those levels of concern risk estimates based on surrogate and detection limit data.
- e) For ecological risk analysis, Industrial Surface Impoundments in the United States does not but should discriminate between the levels of concern estimated using sludge contaminant concentration values reported in survey forms and those levels of concern risk estimates based on calculated sludge data.

#### **3.4.4 Is it likely that EPA's data imputation protocol, or "surrogate data protocol" for imputing waste composition data markedly affected the**

**ultimate conclusions regarding potential risks? If so, in what direction did the protocol probably bias the conclusions?**

The EPA used a structured data imputation protocol when a survey respondent clearly indicated the presence of a particular chemical constituent in an impoundment, but did not indicate a corresponding quantity. EPA used the structured data protocol to impute a surrogate value according to a specific hierarchy of assumptions.

The theme of the imputation methodology is to find the most similar impoundment possible within the survey database that had data for the chemicals without values. The surrogate data protocol is summarized below.

- a) A nearest neighbor imputation methodology was applied to develop surrogate concentration data where chemicals are expected to be present, but quantities are unknown. In cases where the presence of a chemical in an impoundment could be inferred, a value from a similar impoundment was used to represent a likely concentration. As detailed in Industrial Surface Impoundments in the United States surrogate concentrations were developed: "(1) where the respondent had checked the "present but quantity unknown" (PQU) flag, (2) where the respondent had entered a chemical but provided no value (and did not check PQU), and (3) where chemicals were reported in wastewater effluent (to infer presence within the impoundment)."

The imputation methodology employed a decision framework that was programmed into a data processing system to implement the methodology. The process was designed to find the most similar impoundment possible within the survey database that had data for the chemicals without values. The factors considered in order of importance were impoundment location (same facility or similar facility), aeration or not and function (treatment or non-treatment only).

Note that because detection limits were decided to be valid representations of concentrations in the impoundments, the detection limit values derived using the techniques described below were used for surrogates.

- b) When the survey data did not include a sludge concentration and there was sludge within the impoundment, the sludge concentration was determined by employing "wastewater partition coefficients (K<sub>dw</sub>) for metals and a soil organic carbon-water partition coefficient (K<sub>oc</sub>) for organic constituents, along with total suspended solids (TSS) data pulled from the study survey." This calculation was designed to account for contaminants contained by the

suspended solids, because total wastewater concentrations not dissolved wastewater concentrations were reported in the survey data. TSS values were obtained directly from the SI survey database or estimated using other data available for the impoundment. If these were not available a default value was used. The other parameters needed to estimate the partition coefficients were taken from the literature.

Regarding whether the surrogate data protocol for imputing waste composition biased conclusions regarding risk and the direction of any detected bias, the Subcommittee found:

- a) The surrogate data protocol allows for a risk assessment to be conducted when data inputs are incomplete and provides a consistent procedure for selecting surrogate values.
- b) The use of the surrogate data protocol tends to increase the number of risk exceedance impoundments and appears to have a conservative bias in the perspective of protecting human health, when compared to risk assessments performed solely on survey data. A comparison of the risk analysis results indicates that the total number of facilities that exceed risk criteria or may exceed risk criteria approximately doubles when surrogate/DL concentrations are used in addition to reported concentrations.
- c) The surrogate data protocol does not identify the impact on the estimated risks from using the surrogate concentrations versus the "true" concentrations. This impact might have been estimated if acceptable distributions of "true" concentrations could have been specified based on measurements from the other impoundments that had no non-detect data.
- d) The surrogate data protocol uses best available data, but there are no criteria set up to evaluate if "the best available data" meet the quality of data required for the project. The required quality of the risk estimates was not specified, which makes it difficult to specify the quality of data required. If there was a need to estimate risks within say an uncertainty factor of 10, and if uncertainties on model parameters other than concentrations were established, then one could determine what levels of uncertainty in the concentrations would still permit achieving the factor of 10 criteria. Trial and error and sensitivity analyses might have provided some guidance if the adopted structured approach was sufficient.

- 1 e) It may be useful for the EPA to evaluate information on the range of  
2 surrogate data values available for a given constituent at a given  
3 impoundment. If the range of values is small, then the uncertainty in  
4 specifying a surrogate value is somewhat reduced. If the range were large,  
5 then using the maximum surrogate values would be more conservative than  
6 otherwise. Without an evaluation of this range information, the degree of  
7 conservativeness in risk assessments that results from using the maximum  
8 of those values cannot be assessed.
- 9 f) Industrial Surface Impoundments in the United States does not offer any  
10 information as to how the use of the surrogate data protocol biases  
11 ecological risks or risks resulting from indirect pathways.
- 12 g) The charge question cannot be answered properly without performing a  
13 sensitivity analysis. This might be done as follows: Select a subset of  
14 facilities with impoundments that did not require surrogate data. Remove  
15 the quantitative values to create impoundments that require surrogate data.  
16 Apply the imputation methodology to these sites and follow through with the  
17 risk assessment process using the surrogate data. Determine whether the  
18 conclusions of the risk assessment are changed from those obtained before  
19 the original quantitative chemical values were removed. Rather than use  
20 actual impoundments, one could also set up a computer study to do this  
21 investigation. This simulation study could be set up to mimic as closely as  
22 possible the characteristics and types of facilities actually encountered in the  
23 survey. The effect on risk assessment conclusions could be determined for  
24 various amounts of non-detects and non-quantitative responses on survey  
25 forms.

#### 26 **3.4.5 Should EPA have used any other approaches for qualifying or** 27 **presenting surrogate data?**

28 As discussed above, Industrial Surface Impoundments in the United States  
29 discriminates between the direct pathway release and risk estimates based on  
30 contaminant concentration values reported in survey forms and those release and risk  
31 estimates based on surrogate and detection limit data. This distinction is made repeatedly  
32 within the report's executive summary, the body of the report, tables and in its appendices.

33 Regarding whether the EPA should have used other approaches for qualifying and  
34 presenting surrogate data, the Subcommittee found:

- 1 a) The presentation and qualifying approaches were reasonable, intuitive and  
2 readers, who have a range of technical expertise, should understand the  
3 source of releases and risk estimates.
- 4 b) It is not an unreasonable approach to attempt to impute a value from a  
5 similar impoundment or facility. The maximum of all surrogate data values  
6 for a given constituent was used in the survey database for risk assessment  
7 (page A-36 and A-37). That approach is obviously different than selecting a  
8 random value from the set of surrogate values obtained for the constituent.  
9 The selection of a maximum rather than a random value could tend to  
10 increase the risk estimate to some degree. If a random rather than a  
11 maximum surrogate value was used, then the risk estimate could be either  
12 increased or decreased depending on the surrogate value used. It appears  
13 that the EPA chose to be conservative and select a maximum surrogate  
14 value, which would only tend to increase the risk. But there should be some  
15 mechanism for assessing the added uncertainty in risk estimates from using  
16 that approach. This might be accomplished by specifying a subjective  
17 probability distribution of the maximum surrogate values for use in a Monte  
18 Carlo uncertainty analysis of risk. Of course, this distribution would be  
19 different than the distribution that would apply to a randomly selected  
20 surrogate value. Specifying a distribution for the surrogate values would have  
21 permitted an assessment of the effect of surrogate uncertainty on risk  
22 uncertainty.
- 23 c) For indirect exposure pathways and for ecological risks Industrial Surface  
24 Impoundments in the United States does not report separately the levels of  
25 concern estimated using contaminant concentration values reported in  
26 survey forms and those levels of concern based on surrogate and detection  
27 limit data.

28 **3.4.6 Was using the assumption that a chemical could be present up to the**  
29 **detection limit, when it was reported as being present below a**  
30 **detection limit, a reasonable concentration to choose for risk**  
31 **screening purposes?**

32 For purposes of release and risk assessments, survey values, reported as below  
33 detection limits, were not entered into the database as non-detects but entered at the  
34 associated detection level concentration. If a contaminant was reported as non-detect  
35 without an associated concentration value, a look-up table was employed to select a  
36 concentration.

1           Pages 3-4 and 3-5 of Industrial Surface Impoundments in the United States explain  
2 that many different reporting conventions for detection limits were used. Very low and very  
3 high detection limits were reported. The EPA is far less confident in risk assessment  
4 results for situations where detection limits are used in place of actual data values. Hence,  
5 The EPA presented the risk results separately according to whether the risks were  
6 calculated using concentrations reported in the facility surveys or calculated using  
7 surrogates and detection limit concentrations. The EPA states (page 3-6) that risk results  
8 based on reported concentrations have greater certainty than risk results when detection  
9 limits were substituted for unreported concentrations.

10           Much has been written about the treatment of censored/non-detect data, including  
11 guidance offered by the EPA (EPA QA/G-9). Treatment of detection limit data is typically  
12 managed by one of two general methods: substitution or statistical methods. For the  
13 substitution method, the typical approach is to substitute concentrations of zero,  
14 concentrations of half the detection limit or concentrations at the detection limit for non-  
15 detect data. The choice of the substituted concentration is a function of objectives and  
16 decision errors of concern. The statistical method can be used when there are multiple  
17 data points for the population being characterized. For example, censored concentration  
18 distributions below a detection limit can be estimated from non-censored data above the  
19 detection limit, or statistical parameters such as averages can be adjusted to account for  
20 censored portions of the population.

21           Regarding the EPA's assumption that a chemical could be present up to the  
22 detection limit, when it was reported as being below a detection limit, the Subcommittee  
23 found:

- 24           a)     It is reasonable to use the detection limit in place of the non-detect reported  
25 value for purposes of a screening risk assessment. This conservative  
26 approach to screening is also compatible with the approach recommended  
27 in the *Science Advisory Board's Review of the Office of Solid Waste's*  
28 *Proposed Surface Impoundment Study* (EPA-SAB-EEC-98-009). Of  
29 course, this approach will tend to bias high the estimates of risk. However,  
30 this consequence as indicated in the SAB's 1998 report is acceptable and  
31 even desirable for a screening risk assessment.
- 32           b)     A member of the public asked in response to a Subcommittee telephone  
33 conference call as to whether the assumption that a contaminant could be  
34 present at a concentration up to the detection limit is reasonable when the  
35 contaminant was not expected to be present at the facility. The  
36 Subcommittee's response to this expansion to the charge is that the answer  
37 would depend on the certainty with which it is believed that the constituent is

not expected at the facility. Very high certainty would suggest reporting a detection level concentration is not appropriate. Lower certainty regarding the absence of the contaminant would suggest reporting a detection level concentration is appropriate for a screening assessment. The Subcommittee was not charged to address this question, and other than the preceding response is not prepared to address this question on a contaminant by contaminant basis.

**3.4.7 Did the EPA-generated default detection limit protocol provide reasonable approximations of likely detection limits encountered in the field by the facilities, when the detection limits were not reported in the laboratory analysis?**

For purposes of release and risk assessments, survey values, reported as below detection limits, were not entered into the database as non-detects but entered at the associated detection level concentration. If a contaminant was reported as non-detect without an associated concentration value, a look-up table was employed to select a concentration. These lookup tables were based on the wastewater analytical methods for wastewater and SW-846 EPA 8000 series were used for organics in sludge. Detection limits for metals in sludges and for other contaminants in wastewater or sludge that lacked a detection limit, available in a commonly used analytical method, were extracted from the detection limits that existed in the survey database. If an air contaminant was reported as non-detect without an associated concentration value, the detection limit concentration was extracted from a look-up table based on EPA air methods. Detection limits for air contaminants not included in the EPA methods were based on best professional judgment.

All look-up table detection limits were multiplied by a factor of 10 to account for potential interferences.

Regarding whether the default detection limit protocol provided reasonable approximations of likely detection limits encountered in the field, the Subcommittee found:

- a) EPA should provide further information regarding the "look-up" tables of default detection limits to document whether such look-up values can be assumed to be upper limits on actual concentration values.
- b) The detection-limit look up tables incorporated concentration values that were associated with a variety of detection limit [method detection limits (MDL), instrument detection limit (IDL)] and reporting limits [minimum levels (ML), estimated quantitation limits (EQLs)]. The concentrations associated

1 with these different detection and reporting conventions can be significantly  
2 different for the same contaminant (e.g., EQLs concentrations as defined in  
3 RCRA guidance can be as much as 10 times higher than the MDL for the  
4 same compound and for some methods the difference between the EQLs  
5 and IDLs could be even greater). The contaminants (wastewater metals) for  
6 which IDLs were employed, did not suffer from a significant discrepancy as  
7 compared to MDLs, because the referenced method incorporated IDLs from  
8 a dated document based on older and less sensitive instruments and did not  
9 account for the concentration factors that are incorporated into some sample  
10 preparative steps. The use of reporting limits (ML and EQLs) instead of  
11 detection limits resulted in more conservative estimates from the  
12 perspective of protection of human health and the environment.

- 13 c) The EPA increased detection limits by a factor of 10 to account for  
14 interferences. Commonly an analytical interference can require that the  
15 sample be diluted prior to analysis, likewise high concentrations of analytes,  
16 that are of concern, can decrease the effectiveness of preparative  
17 concentration steps that lower method detection limits. The safety factor of  
18 10 should be sufficient for most wastewaters. The EPA, recognizing the  
19 limitation detailed on page 3-4 of the report, should consult the Office of  
20 Water and compare look-up detection limits for sludge contaminants to  
21 those in the survey database in an attempt to determine if the sludge  
22 detection limits are sufficiently conservative.

### 23 **3.4.8 Do the results that are based on imputed/detection limit data suggest** 24 **that further analysis is needed?**

25 For background, please refer to the beginning of Section 3.4.7.

26 Regarding whether the risk results based on imputed/detection limit data suggest  
27 further analysis is needed, the Subcommittee found:

- 28 a) An indication that further analysis is required is when performance criteria  
29 set up before conducting the study are not achieved. The Subcommittee is  
30 unaware as to whether the EPA developed such performance criteria.
- 31 b) The EPA should attempt to groundtruth look-up detection limit concentrations  
32 by comparisons to the field sampling data and detection limits reported in  
33 the survey data.

- c) The SAB's 1998 report made a recommendation to "analyze the sensitivity of the model estimates for the high and low ends of the anticipated parameter distributions". The found the release and risk estimates to be sensitive to the combination of surrogate/detection limit substitutions. It would be valuable to determine the sensitivity of the model outputs for the direct pathways due solely to the detection limit substitution protocol. This sensitivity analysis could be as simple as running the model with concentrations of zero and half the detection level concentrations to determine if the release and risk estimates vary significantly from the more conservative substitution of concentrations at the detection limit. Further sensitivity analyses could be performed to determine the effect on screening risk assessment results if the look-up table detection limit values, themselves, are changed to be larger or smaller than actually used.
- d) Because Industrial Surface Impoundments in the United States did not document the impact of surrogate data/detection limit data versus survey data on ecological and indirect pathway risks, it would be advisable to perform these sensitivity analyses as well as determining the sensitivity to alternative detection limit concentrations as discussed in the previous bullet.

### 3.5 Charge#5 Analysis and implications of field sampling data

#### 3.5.1 What is the SAB's view on EPA's conclusions about the accuracy of the reported survey data on chemical constituent concentrations/quantities?

The introduction to Appendix E of Industrial Surface Impoundments in the United States indicates that the EPA conducted field sampling at a subset of 12 authoritatively selected facilities and subsequently analyzed the collected samples "to supplement other data sources, provide "ground-truth" and fill gaps in data obtained via EPA's *Survey of Surface Impoundments*". Appendix E later identifies the original objectives as;

Objective 1: Determine whether the waste characterization data provided by the facilities in their survey responses and the corresponding sample analysis results from EPA's sampling program are in reasonable agreement and within the range of values expected (i.e., do the EPA data "verify" the survey data).

Objective 2: Determine whether the field sampling and analysis program confirms the presence of constituents reported by the facilities and

1 determine the extent to which the field data identify gaps in the industry-  
2 supplied data.

3 The QAPP captured an expanded list of objectives in the following decision  
4 statements, which are similar to those in DQO Development document (Attachment A to  
5 the QAPP):

- 6 a) Determine, using EPA field monitoring data as a “spot-check” and using  
7 process knowledge, whether or not facility-supplied data are reasonable and  
8 within the range of values expected or whether the data should be  
9 questioned and the discrepancy investigated.
- 10 b) Determine whether or not there are gaps in the industry supplied data and  
11 whether those gaps should be filled by conducting field sampling and  
12 analysis, or by other means (such as requesting additional  
13 information/clarification from the facility).
- 14 c) Determine, using actual field monitoring data (both submitted by facilities  
15 and generated by EPA), whether or not the multimedia models provide  
16 accurate output.

17 The field teams collected samples of impoundment influent and effluent,  
18 wastewater from within the impoundment, sludges, leachate and  
19 groundwater. According to the QAPP, these samples were collected using  
20 judgmental sampling, which relies upon professional judgment to select a  
21 sample that represents the target population. The resulting analytical data  
22 are discussed in the body of Industrial Surface Impoundments in the United  
23 States as well as in appendices C and E and attachments to appendix E.

24 All EPA collected data were subjected to data validation and if the data were  
25 generated under non-compliant analytical conditions, the associated data  
26 were qualified.

27 To evaluate whether the sampling program contaminant concentrations were  
28 within reasonable agreement with the survey data, EPA compared its  
29 measured values with those reported by the facility using several statistical  
30 approaches and concluded that “there is a pattern of agreement between the  
31 waste characterization data provided in the surveys and EPA’s sample  
32 analysis results for the corresponding impoundments, sample locations and  
33 parameters of interest” and that “there is no reason to question the  
34 concentration data provided in the facility survey”.

Regarding the EPA's conclusions about the accuracy of the reported survey data on chemical constituent concentration/quantities, the Subcommittee found:

- a) The Subcommittee, not knowing the representativeness of collected samples nor the true constituent concentrations in the various media sampled at the 12 facilities, is unable to authoritatively determine the accuracy of the sampling data. However, the EPA's use of a structured planning process such as the DQO process, and subjecting the sampling data to data validation are significant steps in respectively assuring and documenting the analytical quality of the data.
- b) The Data Quality Objectives (DQO) process planning effort, which was conducted to support the development of the QAPP, is documented in an appendix to the QAPP. The DQOs specified in the first 4 steps of the DQO process provided in the plan are generally well done, but step 6 ("Specify Limits on Decision Errors) is less satisfactory in that it provides no quantitative basis for determining the number of samples from selected facilities that should be collected. Furthermore, on pages 17 and 18 of the DQO report, the plan called for basing the number of samples for each facility entirely on practical considerations such as budget and schedule, rather than more appropriately basing the number of samples on the quality of the information needed to achieve the purposes of the field sampling program (i.e., validating models, completing the risk analyses, and verifying facility-supplied survey data).
- c) The selection of facilities for subsequent sampling by the EPA was approximately proportional stratified sampling, i.e., roughly 5 to 10 % of the facilities in each of the Standard Industrial Classification (SIC) groups (strata) chosen for sampling. Using proportional stratified sampling is a reasonable approach, although the expected variability in data to be obtained and the representativeness of those data for the population of facilities should have been considered in determining the number of facilities. Nine of the seventeen major SIC groups had no facilities selected for sampling. There was no discussion in Industrial Surface Impoundments in the United States on the sensitivity of the conclusions due to not sampling the 9 SIC groups.
- d) A key consideration in the selection of a facility for subsequent sampling was whether it was located near another facility. One potential problem with this approach is that facilities in close proximity may yield data and information that are redundant. The Subcommittee has not found any analysis or

discussion on the issue of redundancy. Is it possible that redundancies could have occurred because paired facilities were sampled in close proximity in time (both within a given week), perhaps due to similar weather or plant operating conditions? .

- e) Because the actual field samples collected by the EPA were not randomly collected, and because the Subcommittee does not know if the judgmentally collected samples are representative of the media present at the 215 facilities that submitted survey data, the Subcommittee is unable to use the sampling data to authoritatively evaluate the accuracy of the survey data. However, because 88% of the 151 contaminant data pairs are within an order of magnitude of each other and because 78% of time, when there is a difference, the difference is not measurably significant or the survey datum is the higher concentration an argument can be made that the survey data, although positively biased compared to the sampling data, is likely suitable for the study's conservative purpose.
- f) The EPA should attempt to more clearly justify its rationale for its conclusion that "there is no reason to question the concentration data provided in the facility survey" (quote from page 2-10 of Industrial Surface Impoundments in the United States). The EPA should make an effort to explain its conclusion in a more quantitative manner rather than basing it solely on the argument that the data are acceptable because they are typically higher and thus yielding a more conservative risk estimate. EPA expertise regarding the spatial and temporal heterogeneity of wastewaters and impoundment wastes, sampling conditions and the accuracy of analytical methods should be employed to further explore the bias and range of values when comparing sampling data to survey data. For example, if the EPA's sampling was performed during times of elevated temperatures, one may expect a negative bias in volatile organic concentrations in waters versus a 3-year averaged survey datum.
- g) The EPA is encouraged to use the sampling data to evaluate the surrogate data protocol (i.e., use the look-up tables for ND and use the nearest neighbor imputation to see how the imputed data match that which was measured in the field.) The EPA may have performed this evaluation because Page 3-11 of Industrial Surface Impoundments in the United States mentions the important QA role of the sampling data when discussing the "EPA Surrogate Data Protocol". If this evaluation has been performed, the outcome should be more clearly presented.

- h) Approval, during the DQO process, to employ performance-based methods in lieu of existing methodology, for these sample matrices, unnecessarily placed additional burden on the EPA to review the applicability of any non-routine analytical method that was employed and comparability of the resulting data.
- i) DQOs for the field sampling were not consistently presented in the tiered documents (i.e., DQO Development document, QAPP, SAP and Appendix E).

### **3.5.2 What is the SAB's view on EPA's conclusion on the potential incomplete reporting of chemical constituents present?**

**Objective 2: Determine whether the field sampling and analysis program confirms the presence of constituents reported by the facilities and determine the extent to which the field data identify gaps in the industry-supplied data.**

For the second objective the EPA compared the number of constituents reported by each facility for each sample location, to constituents in the related samples collected by the EPA and counted the number of constituents that were detected in both and those additional constituents detected solely in EPA-collected samples.

The EPA found that field sampling typically confirmed the presence of constituents reported by the facilities. They also found that the field sampling confirmed the presence of a number of additional constituents not reported by the facilities.

Regarding the EPA's conclusions on the potential incomplete reporting of chemical constituents, the Subcommittee found:

- a) EPA is correct in concluding that the facility reporting is incomplete.
- b) On page E-17 (bottom) of Appendix E states that quantitation of additional constituents provides supplemental data for possible use in the uncertainty analysis of the study, but it is not clear if this was actually done.
- c) Regarding explanations as to why the facilities did not report the presence of certain constituents, the EPA is encouraged to identify and evaluate local, State and Federal requirements for each of the 12 facilities to determine if the facilities were responsible for detecting the unreported constituents at the concentration levels reported at in the field samples.

1                   **3.5.3 Would the SAB recommend alternate approaches, in order to obtain**  
2                   **the best possible information regarding the exact chemical**  
3                   **constituents present, given the same budget and time constraints?**

4                   In its DQO Development Document, EPA concluded that, “Due to funding and other  
5 practical constraints (e.g., mobilizing field teams to multiple sites) . . . the field sampling  
6 must be limited in scope”. Such budget and time constraints are typical for data collection  
7 activities. Such data collection activities are best designed using a structured planning  
8 process, such as the Data Quality Objective Process used by the EPA, so that an  
9 optimized sampling and analytical design will maximize the return on consumed resources  
10 and increase the chances of achieving objectives.

11                   Regarding the EPA’s request for recommendations under the same budget and  
12 time constraints, the Subcommittee found:

- 13                   a)     The Subcommittee is not familiar with the details of the “budget and time  
14 constraints” that the EPA had to operate under, therefore it is not possible  
15 for the Subcommittee to respond to this question as worded. The  
16 Subcommittee recognizes that the realities of constraints can limit data  
17 gathering, decrease information and increase uncertainty in data-based  
18 decisions. The Subcommittee believes that the EPA did a responsible job of  
19 documenting the constraints and their logic for choosing judgmental  
20 sampling, grouping of facilities and single sampling visits.
- 21                   b)     It would have been advantageous if the survey questions could have been  
22 structured such that more complete and sufficient information on  
23 concentrations was obtained. For example, it would have been helpful if the  
24 EPA decreased the flexibility it allowed in the reporting of chemical  
25 concentrations and non-detect values.
- 26                   c)     More thought should have been given to how the survey and EPA-measured  
27 data would be statistically compared and the requirements of that  
28 comparison, such as comparability of the survey and EPA-measured data.

29                   **3.6. Charge #6: Groundwater Source Term**

30                   In the Surface Impoundment Study, EPA evaluated the risk to human health posed  
31 by chemical constituents migrating from surface impoundments via the groundwater  
32 pathway. A groundwater solute fate and transport model – the EPA Composite Model for  
33 Leachate Migration with Transformation Products (EPACMTP) – was used for this  
34 purpose. The EPACMTP model considers transport in both the vadose and saturated

1 zone. Fate and transport processes included in the model are advection, hydrodynamic  
2 dispersion, equilibrium sorption, and rate-limited chemical hydrolysis. Human health  
3 impacts from ingestion of contaminated groundwater and surface water, and from  
4 ingestion of fish from contaminated surface waters, were considered in the risk  
5 assessments conducted. Exposure scenarios considered in the risk modeling were  
6 ingestion of water from a well downgradient of a leaking surface impoundment, ingestion  
7 of surface water that receives impoundment-contaminated groundwater, and ingestion of  
8 fish residing in the contaminated surface water.

9 The mass rate of release of chemical constituents in liquid from the surface  
10 impoundment into the subsurface constitutes the source term for the groundwater solute  
11 fate and transport model. The properties that define the source term for a particular  
12 chemical constituent or group of constituents are: (1) surface area of the impoundment; (2)  
13 leachate flux from the impoundment, i.e., flow of water leaking out of the bottom and sides  
14 of the impoundment per unit of impoundment surface area; (3) concentration of constituent  
15 or group of constituents in the leachate; and (4) duration of the leachate infiltration. Charge  
16 #6 is focused on item (3), the concentration of chemical constituents in the leachate.

17 Concentrations of chemical constituents in leachate were requested by EPA in the  
18 national survey of surface impoundments. Relatively few facilities in the survey sample  
19 reported leachate data, however, implying that there is little monitoring of the presence and  
20 abundance of chemical constituents in the groundwater beneath and near to surface  
21 impoundments. While leachate data reported were sparse, virtually all facilities that  
22 provided any data on impoundment liquid constituents gave data for impoundment  
23 wastewater composition.

24 In performing the risk modeling for the groundwater pathway, EPA desired to use a  
25 consistent approach for the groundwater source term for the various sites and scenarios  
26 considered. The original intent was to use leachate data for the groundwater source term.  
27 The limited data on leachate composition, however, forced EPA to reconsider this  
28 approach. EPA decided to use impoundment wastewater composition data instead of  
29 leachate data.

30 The core issue relevant to Charge 6 is the use by EPA of wastewater composition  
31 as the source area water composition for the groundwater exposure/risk modeling. EPA  
32 contends that wastewater composition will reasonably approximate leachate composition  
33 for impoundments containing little or no sludge. EPA has some concern, however, that in  
34 impoundments containing some sludge, the concentrations of some constituents could be  
35 considerably different in the pore water of the sludge than in the impoundment wastewater.  
36 EPA's comparison of some field data on sludges with the corresponding wastewater

composition, indicated to the EPA that the decision to use wastewater concentration may have underestimated the contaminant mass for some chemical constituents.

**3.6.1 Charge 6 (a): Would the SAB recommend another approach for representing the groundwater source term, for example, performing a bounding analysis, using the sludge data, where available, to represent an upper bound of the groundwater source term, and using wastewater data as the lower bound, for those chemical constituents for which this situation may be an issue?**

In response to question (a), the SAB supports the EPA approach of using impoundment wastewater composition to define the groundwater source term for steady-state impoundment operation, and does not recommend a bounding analysis using available sludge data. The available sludge data are inadequate in the scope of constituents and conditions represented, and calculating leachate concentrations from sludge concentrations would necessitate assumptions that would lead to substantial uncertainty in the estimates obtained. The use of impoundment wastewater composition to represent impoundment leachate composition is a reasonable, conservative approach for steady-state impoundment operation given the limited submittal of leachate data by survey respondents. It is recommended, however, that the EPA confirm the conservative nature of its approach to groundwater source concentration by comparing leachate concentration data with impoundment wastewater concentration data for those facilities that have reported both kinds of data. In the event that leachate concentrations are found to be consistently greater than wastewater concentrations for some constituents, then EPA should consider the use of the average leachate/wastewater concentration ratio for these constituents as a scaling factor. It would also be useful to demonstrate systematically that the main conclusions from the groundwater pathway risk analysis would not be changed if source area constituent concentrations were higher, e.g., by an order of magnitude. A sensitivity analysis could be performed to examine the effects of increases in constituent source concentrations. It seems unlikely that differences in the source area concentrations in the range of an order of magnitude will change the main conclusions reached in the study.

**3.6.2 Charge 6 (b): Compared to other sources of uncertainty in the groundwater and groundwater to surface water pathway analyses, how large a source of uncertainty does the decision to use wastewater composition data appear to introduce into the overall study conclusions?**

In response to question (b), the main conclusions from the quantitative risk estimation for the groundwater pathway (Section 3.2.3.1) and groundwater-to-surface

1 water pathway (Section 3.3.2.1) were as follows: (i) very few facilities exceeded  
2 acceptable risk criteria with respect to groundwater and surface water ingestion, and  
3 ingestion of aquatic organisms from affected surface waters; (ii) a significant portion of the  
4 facilities that exceed acceptable risk criteria were for the groundwater-to-surface water  
5 pathway were "zero discharge" facilities; and (iii) the highest risks for the groundwater and  
6 groundwater-to-surface water pathways were for impoundments without liners.  
7 Quantification and consideration of the uncertainty in the source area constituent  
8 concentrations likely would not change these conclusions significantly. The numbers of  
9 sites that serve as the basis for these conclusions would change somewhat, but the overall  
10 conclusions would likely remain the same. Given the uncertainty in other risk model  
11 components, e.g., the magnitude of leakage from the impoundments, the simplified  
12 hydrogeological conditions assumed for the groundwater transport modeling, and the  
13 simplified exposure scenarios, the uncertainty in the source area constituent  
14 concentrations is likely to be relatively small.

### 15 **3.6.3 Assessment and Recommendations**

16 The weakness of the EPA approach to defining the groundwater source term -  
17 using the impoundment wastewater composition to represent the composition of leachate  
18 leaking from the impoundment - is that the concentrations of some constituents entering  
19 the groundwater may be significantly different from the concentrations in the impoundment  
20 wastewater. These differences may arise due to reactions in the sludge on the bottom of  
21 the impoundment, or to reactions that occur in the course of transport through the  
22 impoundment liner or barrier material. Moreover, the nature of such reactions may change  
23 over time, as changes in wastewater and sludge composition may lead to changes in the  
24 type and solubility of sludge constituents. Because the source area concentration directly  
25 influences the calculated exposure concentration of a constituent at receptor locations, it  
26 clearly would be best to use leachate data rather than an approximation of leachate data.

27 Defining the groundwater source term as the impoundment wastewater  
28 composition is reasonable in a number of respects, however. It enables consistency in the  
29 risk modeling across all the locations in the survey sample. The wastewater compositions  
30 will only approximate the impoundment leachate concentrations, but the related uncertainty  
31 is likely not greater than the uncertainty that would be involved with estimating the  
32 modification of impoundment wastewater constituent concentrations as a result of  
33 movement through the sludge, liner, and barrier material. In addition, the EPA approach is  
34 not uniformly nonconservative. That is to say, the concentrations of some constituents will  
35 be overestimated by considering the impoundment wastewater as representative of the  
36 leachate. It will not be the case that concentrations of all constituents are underestimated.  
37 For example, the wastewater composition data used appear to be total analysis data,  
38 reflecting analyte present in suspended solids as well as in the aqueous phase. The TSS

1 fraction may not be transportable through the unsaturated and saturated zones. In addition,  
2 some of the surface impoundment analytes of concern, identified in the facility survey, tend  
3 to sorb strongly to earthen materials, and would be unlikely to migrate far past an earth  
4 material liner. Benzo(a)pyrene and benzo(a)anthracene, listed in Table 3-15, are  
5 examples. Fluoride and arsenic, two primary analytes of concern (Tables 3-8 and 3-15),  
6 can also sorb strongly to earthen materials such as oxide minerals under some chemical  
7 conditions, though they also can be completely dissolved under other conditions.

8 The use of impoundment wastewater composition to represent impoundment  
9 leachate composition is a reasonable approach given that the survey respondents  
10 provided limited leachate data. While reactions in the sludge layers, liners, and barrier  
11 materials of impoundments will modify concentrations of some constituents, estimating  
12 these modifications for a large number of sites would yield results with substantial  
13 uncertainty. Significant data collection would be needed to reduce this uncertainty, and if  
14 additional data collection was to be undertaken, it would make most sense to put  
15 resources into acquiring more leachate quality data, which are directly relevant. It would be  
16 very difficult to work in a rationale, defensible manner from sludge data alone. There  
17 would be issues of the representativeness of the data, considering that only small  
18 quantities of sludge are employed in any single sludge analysis, and also a range of issues  
19 related to selection of an appropriate partitioning model.

20 Even if more accurate source area constituent concentrations were obtained from a  
21 new leachate data collection effort, the major conclusions of the risk modeling analysis with  
22 respect to the groundwater pathway would likely remain the same. Consider, for example,  
23 the major conclusion presented on page 3-16 of Industrial Surface Impoundments in the  
24 United States: “the highest risks for the groundwater pathway on an impoundment basis  
25 correlate strongly with the absence of a liner.” This conclusion would not change if the  
26 source area constituent concentrations were higher or lower. Moreover, the EPA risk  
27 analysis indicated that “very few facilities- less than 1 percent” exceeded risk criteria for  
28 analytes of concern in groundwater, considering both direct consumption of groundwater  
29 as well as indirect human exposure through surface water impacted by groundwater  
30 (pages 3-15 and 3-28). This indicates that it would be hard to justify a new leachate data  
31 collection effort in an attempt to refine estimates of low risk. It would be useful to  
32 demonstrate systematically that the main conclusions from the groundwater pathway risk  
33 analysis would not be changed if source area constituent concentrations were higher, e.g.,  
34 by an order of magnitude. The EPA could perform a sensitivity analysis to examine the  
35 effects of increases in constituent source concentrations.

36 Given that some leachate data were acquired in the survey (data are available for  
37 approximately 70 impoundments located at 20 facilities according to EPA), it would be  
38 useful to compare the leachate and impoundment wastewater constituent concentrations

1 reported for these facilities. For each facility, the ratio of leachate concentration to  
2 wastewater concentration could be calculated for each constituent in order to assess with  
3 data the conservative or nonconservative implications of using impoundment wastewater  
4 composition for groundwater source concentration. If the leachate concentration proves to  
5 be systematically higher than the impoundment wastewater composition for some  
6 constituents, perhaps the average ratio of leachate concentration to wastewater  
7 concentration could be used as a scaling factor to calculate the groundwater source  
8 concentration for these constituents. In evaluating trends in the leachate/wastewater  
9 concentration ratios for particular constituents, it will be important to distinguish between  
10 ratios for data from facilities with liners and/or leachate collection systems from those  
11 without such control systems. The ratios for data from facilities without liners will be of  
12 greatest interest. Leachate concentrations at facilities with liners and/or leachate  
13 collection systems are likely to be consistently much lower than impoundment wastewater  
14 concentrations.

15 The Subcommittee generally recommends no change in the EPA approach to  
16 defining the source area constituent concentrations for the groundwater pathway risk  
17 modeling. It is recommended, however, that the EPA confirm the conservative nature of its  
18 approach to groundwater source concentration by comparing leachate concentration data  
19 with impoundment wastewater concentration data for those facilities that have reported  
20 both kinds of data. In the event that leachate concentrations are found to be consistently  
21 greater than wastewater concentrations for some constituents, then EPA should consider  
22 the use of the average leachate/wastewater concentration ratio for these constituents as a  
23 scaling factor.

### 24 **3.7 Recommendations on Future Research Related to Surface Impoundments**

25 The Subcommittee has identified several areas of future research that could  
26 improve the estimation of human-health and ecological risks associated with surface  
27 impoundments. Research areas should be prioritized based on their relative impact on  
28 the reduction of uncertainty for estimating the risks. Therefore, it would be helpful to  
29 conduct sensitivity analyses to identify sensitive parameters. For these parameters, a  
30 higher priority should be given to those that have not been considered in estimating the  
31 risks or do not have sufficient data. The research recommendations include those relevant  
32 to Charge Question 3a, Section 3.3.2.1, concerning the improvement of the screening-  
33 level indirect and ecological risk assessments.

#### 34 **3.7.1 Performance of Surface Impoundments**

- 35 a) Evaluation of the long-term performance of liner systems.

- b) Evaluation of lessons learned from the operation of surface impoundments in the mining and agricultural industries, which were not included in Industrial Surface Impoundments in the United States.
- c) Development of historical and empirical data on surface-impoundment failures due to transient events (natural and man-made), including frequency of and area affected by overtopping and seismic events.
- d) Transfer of the findings of Industrial Surface Impoundments in the United States to the development of technical guidance for designing and operating surface impoundments.

### **3.7.2 Human Health**

- a) Development of health risk indices of the chemicals whose cancer potency values and non-cancer reference doses or concentrations are not available.

### **3.7.3 Ecological Risks (Including Bioaccumulation)**

- a) Biological sampling (e.g., fish and others) of high-risk facilities for persistent constituents after determining a dominant indirect pathway(s).
- b) Investigation on toxicity of chemicals from sludge/soil from surface impoundments to ecological receptors. (It is apparent that toxicity data and exposure factors were only available for 35 of 256 chemicals, p. C-179).
- c) Assessment of potential magnitude of residual risk of chemicals not selected for assessment.
- d) Evaluation of interactions of chemicals in determining toxicity of chemicals from surface impoundments.
- e) Investigation of chronic toxicity to amphibians and reptiles.
- f) Further development of scaling factors for interspecies extrapolation. See Sample and Arenal (1999) for recent factors.

### **3.7.3 Fate and Transport (Air/Groundwater/Soil/Sludge)**

- a) Experimental study on the fate and transport of chemicals in and around aqueous surface impoundments and in soil/sludge from dried out and/or

1 abandoned surface impoundments (so that chemical concentrations in  
2 nearby wetlands can be predicted, or concentrations in soils associated with  
3 overtopping events can be predicted).

4 b) Incorporation (and validation) of additional processes (e.g.,  
5 biotransformation and others) into groundwater transport models to conduct  
6 multi-site evaluation and reduce uncertainty associated with the models.

7 c) Experimental study on the resuspension and subsequent dry deposition of  
8 particles from surface impoundments.

9 d) Investigation of volatilization and subsequent near-field dispersion of SVOCs  
10 and VOCs from water bodies.

11 e) Investigation of volatilization of chemicals from home shower water.

#### 12 **3.7.4 Fate and Transport (Uptake and Bioaccumulation)**

13 a) Experimental study of uptake of chemicals from sludge/soil from surface  
14 impoundments, including SVOCs and VOCs from air by plants and SVOCs  
15 and VOCs from contaminated soil by plants. See Efroymson et al. (2001)  
16 for a compilation of data (and regressions) on plant uptake of 8 inorganic  
17 chemicals from various contaminated soils.

18 b) Measurement of tissue levels of persistent or bioaccumulative chemicals  
19 (e.g., dioxin, methyl mercury) in human and wildlife foods, such as fish, near  
20 surface impoundments.

21 c) Investigation of the interactions of chemicals in determining bioaccumulation  
22 of chemicals from surface impoundments.

#### 23 **3.7.5 Risk Assessment Methodologies (Model Development and** 24 **Validation)**

25 a) Evaluation of 3MRA (originally intended for use in this study, p. C-2) or  
26 another multimedia model for use in assessing risks from surface  
27 impoundments.

28 b) Incorporation of a probabilistic approach into the quantitative risk  
29 assessment of air-human risk pathways by making use of the progress  
30 made in this area especially within EPA. (The Subcommittee understands

that it would be difficult to develop distributions on human health effects [e.g., cancer potency]).

c) Development of probability distributions for those significant parameters used in CHEMDAT8.

d) Evaluation of the role of model uncertainty as part of the total uncertainty in risk results.

e) A study of sensitivity of the risk and hazard measures to alternative assumptions regarding hazard and potency.

f) A study of sensitivity of the risk to presumptions regarding biophysical and photochemical conversions.

### 3.7.7 Mitigation measures

a) The study of methods to discourage biota from colonizing surface impoundments.

## References

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**APPENDIX A**

**ROSTERS AND BIOS FOR THE SUBCOMMITTEE**

FY 2002 Executive CommitteeC Roster  
FY 2002 Environmental Engineering Committee Roster  
FY2001-02 Surface Impoundments SubcommitteeRoster  
Bios for the Subcommittee

**U.S. Environmental Protection Agency  
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9 \* Members of this SAB Panel consist of

10 a. SAB Members: Experts appointed by the Administrator to serve on one of the  
11 SAB Standing Committees.

12 b. SAB Consultants: Experts appointed by the SAB Staff Director to a one-year  
13 term to serve on ad hoc Panels formed to address a particular issue.

14 c. Liaisons: Members of other Federal Advisory Committees who are not Members  
15 or Consultants of the Board.

16 d. Federal Experts: The SAB charter precludes Federal employees from being  
17 Members of the Board. "Federal Experts" are federal employees who have technical  
18 knowledge and expertise relevant to the subject matter under review or study by a  
19 particular panel.

## BIOS FOR THE SUBCOMMITTEE

**Dr. David A. Dzombak**, received his Ph.D. in Civil-Environmental Engineering from the Massachusetts Institute of Technology. He is a Professor of Civil and Environmental Engineering at Carnegie Mellon University, a registered Professional Engineer in Pennsylvania, and a Diplomat of the American Academy of Environmental Engineers. The emphasis of his research is on water and soil quality engineering, especially the fate and transport of chemicals in subsurface systems and sediments, wastewater treatment, in situ and ex situ soil/sediment treatment, hazardous waste site remediation, and abandoned mine drainage remediation. Dr. Dzombak has served on the National Research Council Committee on Bioavailability of Contaminants in Soils and Sediments, and on various research review panels for the Department of Defense, Environmental Protection Agency, National Institute of Environmental Health Sciences, and National Science Foundation. He has also served on the Board of Directors and as an Officer of the Association of Environmental Engineering and Science Professors; as chair of committees for the American Academy of Environmental Engineers, American Society of Civil Engineers, and Water Environment Federation; and on advisory committees for various community and local government organizations, and for the Commonwealth of Pennsylvania.

**Dr. Rebecca A. Efroymson** is a Research Staff Member in the Environmental Sciences Division, Oak Ridge National Laboratory, U.S.A. She has a Ph.D. in Environmental Toxicology from Cornell University. Her research experience includes the development of frameworks, toxicity benchmarks and models for ecological risk assessment, with emphases on contaminated soils, air pollutants, plants, microorganisms, and soil invertebrates. She has led and provided technical support for ecological risk assessments of contaminated burial grounds, streams, ponds, and watersheds for U. S. Department of Energy facilities in Oak Ridge, TN. She has contributed ecological components to an EPA multimedia model for air pollutants. She is developing improved tools and methods for ecological risk assessment at petroleum-contaminated sites, including landscape ecological approaches. She has led an ecological risk assessment for land application of sewage sludge in forests and arid ecosystems. She has developed an ecological risk assessment framework for military aircraft overflights (e.g., impacts of noise) and contributed to a broader risk assessment framework for military training and testing activities. Prior to working in Oak Ridge, she was an American Association for the Advancement of Science Diplomacy Fellow at the U. S. Agency for International Development, where she was involved in comparative risk assessment and pollution prevention programs. She also has research experience related to the biodegradation of hydrocarbons.

1 **Dr. Richard O. Gilbert** received his Ph.D in Biomathematics from the University of  
2 Washington, Seattle, Washington. He is a Staff Scientist in the Statistical and Quantitative  
3 Sciences Group at Battelle, Pacific Northwest Division in Richland, Washington. Dr.  
4 Gilbert is currently located at the Battelle Washington Office in Washington D.C. He has  
5 32 years experience at Battelle in the statistical design and analysis of environmental  
6 studies to assess radionuclide and chemical contamination and cleanup in environmental  
7 media, with emphasis on the Nevada Test Site and other Department of Energy sites. He  
8 is perhaps most well known for his often-cited reference book *Statistical Methods for*  
9 *Environmental Pollution Monitoring* published in 1987. Dr. Gilbert's recent activities  
10 include contributing to the development of EPA guidance documents and teaching short  
11 courses on the Data Quality Objectives planning process and environmental statistical  
12 design and analysis methods, developing statistical designs for the detection of  
13 unexploded ordnance at Department of Defense sites, and assisting with the development  
14 of the *Visual Sample Plan* software that helps environmental professionals determine the  
15 right number and location of environmental samples. Dr. Gilbert has also managed and  
16 conducted Monte Carlo uncertainty and sensitivity analyses of environmental models, with  
17 particular emphasis on reconstructing doses received by the public from Iodine-131  
18 emissions from the Hanford Site in Washington State in the 1945-1963 time period. Dr.  
19 Gilbert has served as a consultant to the EPA Science Advisory Board (SAB) on the  
20 Drinking Water Committee, the Statistical Consultation Subcommittee of the  
21 Environmental Engineering Committee, and Surface Impoundments Subcommittee of the  
22 Environmental Engineering Committee. He has also served as a member of the Health  
23 Physics Society's N13.31 Working Group that is writing the American National Standards  
24 Institute (ANSI) Standard *Assessment of Radiation Doses Resulting from Plutonium and*  
25 *Americium from Soil*. Dr. Gilbert is a Fellow of the American Statistical Association  
26 (ASA) and an elected member of the International Statistics Institute. He was also elected  
27 Chair of the Environmental Statistics Section of the ASA in 1995 and was awarded the  
28 Distinguished Achievement Award from the Section.

29 **Dr. Thomas M. Holsen**, received his Ph.D. in Civil Engineering from the University of  
30 California at Berkeley. He is a Professor of Civil and Environmental Engineering at  
31 Clarkson University. His research interests include the transport, transformations and fate  
32 of hydrophobic organic chemicals, metals, and ions in the atmosphere. Recently he was  
33 responsible for determining the importance of dry deposition during the Lake Michigan  
34 Mass Balance Study and is currently investigating the transport and deposition of  
35 pollutants in New York State, to the Hudson River Estuary and to the Chesapeake Bay. He  
36 was a reviewer of several congressionally mandated reports on the importance of  
37 atmospheric deposition to the Great Waters and recently testified at a Congressional  
38 briefing on the persistent organic chemicals negotiations. He has published extensively on  
39 the absolute and relative importance of atmospheric deposition of toxic substances in and  
40 their cycling within several large ecosystems. He regularly teaches a graduate course on  
41 the transport of pollutants in the environment. He has over 65 publications and has

1 successfully supervised research projects from industrial sources and State and Federal  
2 Agencies.

3 **Dr. Hilary I. Inyang** is the Duke Energy Distinguished Professor of  
4 Environmental Engineering and Science, Professor of Earth Science and  
5 Director of the Global Institute for Energy and Environmental Systems at the  
6 University of North Carolina-Charlotte. He holds a Ph.D. in geotechnical  
7 engineering and materials, with a minor in mineral resources, from Iowa  
8 State University. Prior to his current position, he was University  
9 Professor, Dupont Young Professor and Director of the Center for  
10 Environmental Engineering, Science and Technology (CEEST) at the University  
11 of Massachusetts, Lowell. His research and allied professional activities  
12 have focused on waste containment systems, contaminant leachability, soil /  
13 contaminant physico-chemical interactions, natural disaster mitigation  
14 techniques, rock fragmentation techniques for energy installations and  
15 underground space, and energy / environmental policy. His projects have been  
16 sponsored by federal agencies such as US. Department of Defense, U.S.  
17 Environmental Protection Agency, U.S. Department of Agriculture, National  
18 Oceanic and Atmospheric Administration, Federal Highway Administration and  
19 the United States Agency for International Development. He has authored /  
20 co-authored several research articles, book chapters, federal design manuals  
21 and the textbook *Geoenvironmental Engineering: principles and applications*,  
22 published by Marcel Dekker. He is an associate editor / editorial board  
23 member of eight refereed international journals and contributing editor of  
24 three books, including the United Nations Encyclopedia of Life Support  
25 Systems (Environmental Monitoring Section). From 1997 to 2001, Dr. Inyang  
26 served as the chair of the Environmental Engineering Committee of USEPA's  
27 Science Advisory Board. He is a member of the National Advisory Council on  
28 Environmental Policy and Technology (Effluent Guidelines Committee) and has  
29 served on more than sixty international, national and state science  
30 /engineering panels and committees. He is currently the elected president of  
31 the newly-formed International Society of Environmental Geotechnology and  
32 has co-chaired several international conferences in the US, Brazil, China,  
33 Canada and Japan since 1995. Dr. Inyang is a former AAAS/USEPA Environmental  
34 Science and Engineering Fellow, National Research Council Young Investigator  
35 (1997) and Eisenhower Fellow of the World Affairs Council (1992/93).

36 **Dr. Michael C. Kavanaugh** is Vice President and the National Science and Technology  
37 Leader for Malcolm Pirnie, Inc. He is a chemical and environmental engineer with over 27  
38 years of consulting experience. He has provided a broad range of consulting engineering  
39 services to private and public sector clients both in the U.S. as well as western Europe and  
40 parts of Asia. His areas of expertise include hazardous waste management, site  
41 remediation, strategic environmental management, risk analysis, water quality, water

1 treatment, industrial and municipal wastewater treatment and technology evaluations  
2 including patent reviews. Dr. Kavanaugh has extensive litigation experience, and has been  
3 a designated expert in his areas of expertise in numerous cases. He has also been  
4 selected to serve as a neutral technical mediator or arbitrator on several large litigation  
5 cases. Dr. Kavanaugh has been project engineer, project manager, principal-in-charge,  
6 technical director or technical reviewer on over 200 projects covering a broad range of  
7 environmental issues. Dr. Kavanaugh has prepared over 35 peer reviewed technical  
8 publications, edited two books, and has made over 100 presentations to technical  
9 audiences as well as public groups. Dr. Kavanaugh was the Chair of the Water Science  
10 and Technology Board of the National Research Council from 1989 to 1991. During this  
11 time, the Board managed or developed over 15 projects related to all aspects of water  
12 resources management. From 1994 to 2000, he chaired the Board on Radioactive Waste  
13 Management, a Board responsible for evaluating the Nation's strategies for management  
14 of radioactive waste. He recently served on the Board of Scientific Counselors, advising  
15 the Assistant Administrator of the Office of Research and Development in the EPA. He is  
16 currently on the Editorial Advisory Board for the Environmental Science and Technology  
17 Journal, published by the American Chemical Society. He was elected to the National  
18 Academy of Engineering in 1998.

19 Dr. Kavanaugh has a B.S. and a M.S. in Chemical Engineering from Stanford and the  
20 University of California, Berkeley, respectively. He received his PhD in Civil/Environmental  
21 Engineering from UC Berkeley in 1974. He is a registered professional engineer in  
22 several states and is a Diplomate of the American Academy of Environmental Engineers,  
23 a designation that requires regular confirmation of professional standing.

24 **Dr. Byung R. Kim** received his Ph.D. in Environmental Engineering from the University of  
25 Illinois, Urbana, IL. He is now Staff Technical Specialist in the Chemistry and  
26 Environmental Science Department of Ford Research Laboratory, Dearborn, MI and is a  
27 professional engineer. His current research interest is in understanding various  
28 manufacturing emission issues (physical/chemical/biological waste treatment processes  
29 and the overall environmental impact of manufacturing processes). He also has worked on  
30 the adsorption of organics on activated carbon and water quality modeling. He has served  
31 on the EPA SAB Environmental Engineering Committee and was Editor of the Journal of  
32 Environmental Engineering, American Society of Civil Engineers (ASCE). He served on  
33 the advisory board for the National Institute of Environmental Health Superfund Basic  
34 Research Program at the University of Cincinnati. He received a Richard R. Torrens  
35 Award for editorial leadership from ASCE and two Willem Rudolfs Medals from Water  
36 Environment Federation on his publications.

37 **Dr. John P. Maney** received his Ph.D. in Analytical Chemistry from the University of  
38 Rhode Island, Kingston, Rhode Island. Dr. Maney has over 30 years experience in  
39 analytical chemistry and over 20 years experience in environmental sampling,  
40 environmental analysis and data quality issues. He has directed and founded

1 environmental testing laboratories, managed numerous government contracts and  
2 subcontracts, which have addressed among other issues, analytical method development,  
3 analytical method validation, hazardous waste sampling, and authoring of guidance. Dr.  
4 Maney has chaired and participated in the consensus standard process for USEPA/ASTM  
5 accelerated standards regarding sampling, subsampling and data quality. For the last 11  
6 years he has been president of Environmental Measurements Assessment (EMA), a  
7 consulting company that focuses on sampling, analytical and quality issues.

8 **Dr. Michael J. McFarland** received his bachelors' degree in Engineering and Applied  
9 Science from Yale University, his masters' degree in Chemical Engineering from Cornell  
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11 is currently an associate professor in the Department of Civil and Environmental  
12 Engineering at Utah State University where his research interests are focused in the areas  
13 of air quality management, industrial waste management and pollution prevention. Dr.  
14 McFarland has served on numerous federal, state and local environmental engineering  
15 and public health advisory committees for the US Dept. of Defense, US Environmental  
16 Protection Agency, US Dept. of Energy, National Science Foundation, Utah Dept. of  
17 Environmental Quality and Cache County, Utah. Dr. McFarland has authored or  
18 coauthored over fifty publications in the field of environmental engineering including  
19 engineering textbooks, workbooks, journal articles and conference proceedings. Dr.  
20 McFarland is a registered professional engineer in the State of Utah and currently holds  
21 Grade IV operator certifications for both wastewater and water treatment. Dr. McFarland  
22 is a member of the American Academy of Environmental Engineers (AAEE), the Water  
23 Environment Federation (WEF), the Society for Risk Analysis, National Biosolids  
24 Partnership and the Association of Environmental Engineering and Science Professors  
25 (AEESP).

26 **Dr. Makram T. Suidan**, received his Ph.D. in Environmental Engineering from the  
27 University of Illinois. He is now the Herman Schneider Professor of Environmental  
28 Engineering and Director of the Environmental Engineering and Science Program at the  
29 University of Cincinnati. Dr. Suidan's principal research interests are in the areas of  
30 physical, chemical and biological treatment of hazardous wastes, anaerobic and aerobic  
31 biological treatment of municipal and industrial wastes, applications of membrane  
32 technology to biological treatment systems, biological treatment of gas phase pollutants,  
33 and bioremediation of spilled oil and hydrocarbons. Much of his work focuses on the  
34 development of unit processes for the treatment of difficult to handle wastewaters. For  
35 example, major effort in Dr. Suidan's laboratory is directed towards the development of  
36 low-cost ex-situ processes for the biological treatment of gasoline oxygenates. These  
37 processes rely on membrane technology to harvest difficult to grow microorganisms. Dr.  
38 Suidan has authored and co-authored over 170 refereed journal articles and over 160  
39 conference proceedings. Dr. Suidan was the 1996 Association of Environmental  
40 Engineering and Professors Distinguished Lecturer and is the recipient of many honors  
41 and awards for his research. He was editor in chief for the Journal of Environmental

1 Engineering, ASCE and Chair of the Science Advisory Committee for one of the EPA  
2 Hazardous Substances Research Centers. He has served on a number of panels for the  
3 NSF, EPA, and DOE.

4 **Dr. Lauren Zeise** is Chief of Reproductive and Cancer Hazard Assessment within the  
5 California Environmental Protection Agency's Office of Environmental Health Hazard  
6 Assessment. She has served in that position since 1991. She first came to state service  
7 in 1988. In that position she oversees a variety of the state's cancer, reproductive and  
8 ecological risk assessment activities.

9 Her group evaluates and provides advice on cancer, reproductive and ecological risks  
10 posed by environmental contaminants, and develops policy guidance for conducting such  
11 assessments. The group also conducts scientific evaluations mandated by Proposition 65  
12 and evaluates the risks from use of drugs, cosmetics, gasoline and other products. It is  
13 also developing the state's guidance on evaluating risks stemming from the exposure of  
14 children, infants and fetuses to cancer-causing substances.

## APPENDIX B

### SUMMARY OF ELEMENTS OF THE EPA QUALITY SYSTEM

The Agency's quality **policy** is consistent with ANSI/ASQC E-4 and is defined in EPA Order 5360.1 CHG 1 (1998), the Quality Manual and the organizational components designed for policy implementation as described by the Agency's **Quality System** (EPA QA/G-0). The quality system provides the framework for planning, implementing, and assessing work performed by the organization for carrying out required quality assurance and quality control.

EPA has a comprehensive system of tools for managing its data collection and use activities to assure data quality. The **management tools** used in the organizational level of the EPA Quality System include Quality Management Plans and Management System Reviews. The **technical tools** used in the project level of the EPA Quality System include the Data Quality Objectives Process, Quality Assurance Project Plans, Standard Operating Procedures, Technical Assessments, and Data Quality Assessment.

At the management level, the **Quality System** requires that organizations prepare **Quality Management Plan** (QMP). The QMP provides an overview of responsibilities and lines of authority with regards to quality issues within an organization. Therefore, not only does ETV have a QMP, but the verification partners and subcontractors are required to develop and implement their own QMPs. The ETV program calls these documents **Quality and Management Plans**.

Organizations with **QMPs** review their own performance and develop **Quality Assurance Annual Report and Work Plans** (QAARWP) that provide information on the previous year's QA/QC activities and those planned for the current year. The QAARWP functions as an important management tool at the organizational level as well as at the Agency-wide level when QAARWP supplied information is compiled across organizations.

At longer multi-year intervals EPA conducts periodic **Management System Reviews** for organizations. An **MSR** consists of a site visit; a draft report that details findings and recommended corrective actions, consideration of the reviewed organization's formal response to the draft report and the authoring of a final report.

At the project level, the data life cycle of planning, implementation and assessment becomes important. The data life cycle begins with systematic planning. EPA recommends that this required planning be conducted using the **Data Quality Objectives (DQO) Process**. The DQO process includes seven steps:

1. State the problem
2. Identify the decision
3. Identify the inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify tolerable limits on decision errors
7. Optimize the design

The **Quality Assurance Project Plan (QAPP)** is the principal output of the **DQO** process and is the project-specific blueprint for obtaining data appropriate for decision-making. The QAPP translates the DQOs into performance specifications and QA/QC procedures for the data collectors. In the ETV program the **QAPPs** are known as **Test/QA plans**; these provide a second level of assurance that the technology verification test will be performed in a manner to generate objective and useful information of known quality.

The final step in the data life cycle is the **Data Quality Assessment (DQA)** which determines whether the acquired data meet the assumptions and objectives of the systematic planning process that resulted in their collection. In other words, the DQA determines whether the data are usable because they are of the quantity and quality required to support Agency decisions.

## ACRONYMS & GLOSSARY

Do we need this?

deterministic

EEC Environmental Engineering Committee

EPA Environmental Protection Agency

LDPFA Land Disposal Program Flexibility Act of 1996, or

OSW Office of Solid Waste

probabilistic

RCRA Resource Conservation and Recovery Act, or

SAB Science Advisory Board

uncertainty

variability